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BORE EROSION AND ACCURACY OF M16A1 RIFLE

DR. RAO YALAMANCHILI

FEBRUARY 1977

FINAL REPORT

RESEARCH DIRECTORATE

GENERAL THOMAS J. RODMAN LABORATORY
ROCK ISLAND ARSENAL
ROCK ISLAND, ILLINOIS 61201

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An analysis was conducted on the performance of M16A1 rifles made by three manufacturers with the use of two kinds of ammunition and three rates of fire. ~~The~~ data include extreme spread and bore erosion gage measurements, each as a function of the number of rounds fired. Consistency is lacking in the experimental data, even though identical tests were performed. Probably, ~~the~~ random vibrations of the gun barrel or other unknown phenomena may be the reason for inconsistency of spread data. ~~The~~ inconsistency in the penetration of erosion (cont on p ii)

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gages may be due to fouling deposits on the bore surface and to lack of properly designed tools for unique measurements. Large variations occur in the useful life of the barrels due to variations in manufacturing, ammunition, and firing rate. The typical rate of erosion is about one-thousandth of an inch per thousand rounds of fire. Gage Number 6 may be used to measure barrel erosion and ultimately to indicate when to discard the barrel. ~~The~~ erosion increases and ~~the~~ useful life of the weapon decreases with increase in rate of fire. The useful life of the weapon may be approximated as inversely proportional to the two-third power of the firing rate.

A

CONTENTS

A

I. INTRODUCTION

M16A1 rifles are made by three manufacturers. In addition to the variations of the different manufacturers, two kinds of ammunition and three firing rates are utilized. It is possible to consider a consistency test for standard ammunition, M193 ball propellant. Thus, 27 weapons are involved in this experimental investigation. The weapon identifications are shown in Table I.

The experimental data are tabulated in Reference 1. These data include mean radius and extreme spread of hits on the target, and nine different gage penetrations in the barrel bore near the origin of rifling as functions of number of rounds fired. Since mean radius is considered by small arms specialists as an unimportant factor in barrel selection, no utilization is made of the mean radius data in this study.

It is the objective of this task to recommend a gage and criteria (how much penetration or erosion into the bore) to condemn a barrel, based on the existing data of extreme spread and various gage penetrations as reported in Reference 1.

Since the extreme spread is an indication of the accuracy of a weapon, the spread data as reported in Reference 1 is shown in Figures 1 thru 27. The variable parameter consists of Targets #1, #2, #3 and a mean of all these three targets. The extreme spread of each target is based on a group of 10 rounds. The quality of data is poor. Since there are large variations from one target to another and the data varies in a random manner, it does raise some questions; such as, can the mean of extreme spread of three different targets be the same as if all 30 rounds were fired on the same target? Further experimentation is needed to answer such questions. If the data had been analyzed while the test was in progress, the quality of data might have been improved by eliminating the randomness of data or by redesigning the experiments.

TABLE I

GUN IDENTIFICATION

Gun No.	Barrel No.	Ammunition	Firing Rate in Rounds Per Minute
01	C1	M193 Ball	20
02	C2	M193 Ball	20
03	C3	M196 Tracer	20
04	C4	M193 Ball	60
05	C5	M193 Ball	60
06	C6	M196 Tracer	60
07	C7	M193 Ball	100
08	C8	M193 Ball	100
09	C9	M196 Tracer	100
10	GM1	M193 Ball	20
11	GM2	M193 Ball	20
12	GM3	M196 Tracer	20
13	GM4	M193 Ball	60
14	GM5	M193 Ball	60
15	GM6	M196 Tracer	60
16	GM7	M193 Ball	100
17	GM8	M193 Ball	100
18	GM9	M196 Tracer	100
19	M1	M193 Ball	20
20	M2	M193 Ball	20
21	M3	M196 Tracer	20
22	M4	M193 Ball	60
23	M5	M193 Ball	60
24	M6	M196 Tracer	60
25	M7	M193 Ball	100
26	M8	M193 Ball	100
27	M9	M196 Tracer	100

II. IDENTICAL TESTS

Some of the tests were conducted with identical weapons (same material, design and manufacturer), same ammunition, and also same firing rate. For example, C1 is identical to C2. Similar pairs are C4 = C5, C7 = C8, M1 = M2, M4 = M5, M7 = M8, GM1 = GM2, GM4 = GM5 and GM7 = GM8. It is logical that the results such as extreme spread, mean radius and penetration by respective gages would be identical because the test conditions were identical. The actual variations in results are not reasonable based on the above test conditions. Since there is no consistency in the data and reasons are unknown other than the mentioned round-to-round ammunition variations and lack of unique (quantitative) measurements, it is recommended that curve fitting techniques be utilized and consider the spread of data at the critical point rather than use rigid rules such as the first data point that exceeds an extreme spread of 7 inches.

The extreme spread versus number of rounds is shown in Figures 28 thru 54. The average spread of all targets is used rather than the data of individual targets. A quadratic equation with method of least squares (i.e., a particular case of method of weighted residuals) was used to correct the data further. It is possible to use these curves in order to estimate the useful life of the barrel for any tolerance (chosen criteria) of extreme spread. The useful life of the barrel is given in Table II for extreme spreads of 7 and 9 inches. This table shows variations not only due to various manufacturers but also between guns from the same manufacturer. The useful life of weapons with tracer ammunition is more than the range of experimental data that exists and, therefore, cannot be predictable. There are no attempts to extrapolate the data because of unknown behavior for larger number of rounds fired.

This table also shows that the useful life of the weapon varies from 5,150 to 21,480 rounds (or 30,600 if extrapolated just outside of the range for another gun, GM2) for conventional ammunition provided the allowance of 7 inches of extreme spread criteria is chosen. The similar useful life of the barrels is 7,124 to 29,058 rounds for 9 inches extreme spread criteria, (extrapolation is not meaningful for the larger extreme spread criteria). The minimum service life is indicated for M7 and the maximum for C2. The useful service life is given in Table III for the tests that are considered to be identical.

In general, the variations are extensive and there is no consistency. It is very difficult to predict what the results will be if human interference (various soldiers) different field conditions and combat zone pressures are involved.

Moreover, the quality and quantity of data can make significant differences in the end results. For example, Figure 29 is redrawn with less quantity of data. This is shown in Figure 55 (Punched Data supplied by Tom Nathan, Application Engineering Directorate, GEN Thomas J. Rodman Laboratory). The curve trends are quite different between Figures 29 and 55.

TABLE II

USEFUL LIFE OF BARRELS

Gun No.	Barrel No.	Ammunition	Firing Rate	Life up to an Extreme Spread of: 7"	9"
01	C1	M193 Ball	20	16,610	
02	C2	M193 Ball	20	21,480	29,058
03	C3	M196 Tracer	20	30,000+	
04	C4	M193 Ball	60	10,960	13,389
05	C5	M193 Ball	60	10,060	13,700
06	C6	M196 Tracer	60	15,000+	
07	C7	M193 Ball	100	7,590	7,589
08	C8	M193 Ball	100	10,960	13,655*
09	C9	M196 Tracer	100	15,500+	
10	GM1	M193 Ball	20	18,840	23,682
11	GM2	M193 Ball	20	30,600*	
12	GM3	M196 Tracer	20	30,000+	
13	GM4	M193 Ball	60	11,950	14,450
14	GM5	M193 Ball	60	11,070	14,943
15	GM6	M196 Tracer	60	15,000+	
16	GM7	M193 Ball	100	7,350	9,237
17	GM8	M193 Ball	100	8,140	9,786
18	GM9	M196 Tracer	100	15,500+	
19	M1	M193 Ball	20	7,110	10,432
20	M2	M193 Ball	20	10,760	15,011
21	M3	M196 Tracer	20	30,000+	
22	M4	M193 Ball	60	5,870	8,911
23	M5	M193 Ball	60	7,110	10,380
24	M6	M196 Tracer	60	15,000+	
25	M7	M193 Ball	100	5,150	7,124
26	M8	M193 Ball	100	5,990	7,897
27	M9	M195 Tracer	100	15,500+	

* Extrapolated

\+ Too much out of range

TABLE III

PAIRS OF IDENTICAL TEST CONDITIONS

Weapon	Life upto an Extreme Spread of: 7"	9"
C1	16,610	
C2	21,480	29,058
C4	10,960	13,389
C5	10,060	13,700
C7	7,590	7,589
C8	10,960	13,655
GM1	18,840	23,682
GM2	30,600*	
GM4	11,950	14,450
GM5	11,070	14,943
GM7	7,350	9,237
GM8	8,140	9,786
M1	7,110	10,432
M2	10,760	15,011
M4	5,870	8,911
M5	7,110	10,380
M7	5,150	7,124
M8	5,990	7,897

* Extrapolated

III. GAGE PENETRATION

An ideal gage is one that does not penetrate at the beginning of the firing program, but penetrates rapidly as the end of the useful life of the barrel is approached. According to this definition, the penetration versus number of rounds or percentage of life graph should resemble an exponential curve.

If the useful life of the barrel is large (30,000 rounds), a higher gage number such as nine should be used, and if the useful life of the barrel is small (6,000 rounds), a lower gage number such as one would be better. For medium range useful life of the barrels, a medium gage number such as six would be preferred.

In general, the increase in penetration of any of the gages used is quite limited (up to 1.5 inches). However, the actual penetration up to the useful life of the barrel is only a fraction of the maximum penetration.

IV. BORE PROFILES

There are nine gages. Since each gage has a different diameter, it is possible to obtain the diameter of a tapered bore as a function of distance of gage penetration. It is also possible to determine the spread of erosion and the rate of erosion provided one measures the bore profile with this set of gages at different rounds of fire. Such information does exist near the origin of rifling for M16A1 automatic rifles.

Typical data are shown for Barrel C1 (Figure 56). The x-axis represents the penetration of gages or axial distance along the barrel from the breech-end reference point. The y-axis represents the bore diameter. The number-of-rounds fired is the variable parameter. The first symbol (octagon) represents the data of a new rifle. The second symbol (triangle) indicates the bore profile after firing 5,000 rounds of ammunition. The subsequent curves are made at 5,000 rounds intervals. No data are plotted beyond 25,000 rounds because of the limitation of the number of curves that can be plotted in a single graph. The bore profiles are also curve fitted with a polynomial of degree 2 and by the use of the method of least squares, i.e., a particular case of the method of weighted residuals.

The constant diameter line for each gage is also drawn not only to show the penetration of that gage at any time but also to interpret the rate of spread of erosion into the rifled bore. The rate of spread of erosion can be calculated by noting the difference in penetration of the smallest gage between known (elapsed) rounds of fire. The rate of spread of erosion increases with increase in number of rounds fired. It is to be noted that the rate of spread of erosion discussed here is applicable only for tapered sections of the barrel, but not for straight sections of the barrel.

Similar to the rate of spread of erosion in a longitudinal direction (along the bore), one can also compute the rate of erosion of bore surface (in a transverse direction). Since the x-axis represents the distance along the bore surface (from a known reference point at the breech end), one can draw a vertical line at any desired location and measure the difference in bore diameter between known (elapsed) rounds of fire in order to obtain the rate of erosion. The typical rate of erosion is about one-thousandth of an inch per thousand rounds of fire.

Similar data for other weapons are shown in Figures 57 thru 82. The bore profiles are prepared at 5,000 round intervals for 20 and 60 rounds per minute firing schedules. The plotting interval for 100 rounds per minute firing schedule is 2,500 rounds. There is not much inconsistency in penetration of any one particular gage for Barrels C1 thru C9 and also M1 thru M9. However, there is inconsistency in the penetration data of Weapons GM1 thru GM9. For example, the initial penetration of ages 2 and 3 is always greater than the penetration of the same gage after several thousand rounds of fire, even though this would seem to be physically impossible. These inaccuracies in the penetration of gages may stem from the possibility of bore deposits (coatings) by foreign material, lack of adequate and consistent cleaning before penetration measurements and, lastly, variations in the insertion of gages due to inadequate feeling of drag from person to person. The bore deposits are possibly due to melting of copper (bullet material) because of friction between bullet and bore and also movement of propellant grains near the bore surface. These deposits or coatings may be hard and thus difficult to remove by ordinary cleaning methods. It is quite difficult to recognize the differences in the drag of gage insertion in a bore. Therefore, the penetration measurements not only can vary from person to person but also can be different when taken by the same person, especially with small diameter gages. The gages numbered 6, 7, 8 and 9 penetrate more gradually as firing (number of rounds) progresses than the group with Gage Numbers 5, 4, 3, 2 and 1. Since this latter group leads to inconsistency and thus is subjected to either loss of economy or increase in enemy threat due to lack of firing accuracy, it is recommended that the larger diameter gages numbered 6, 7, 8 and 9 be used wherever possible.

V. GAGE ANALYSIS

The useful life of a weapon is defined as the number of rounds that are fired without exceeding the assigned or chosen tolerance on extreme spread. Table II shows that the useful life of a weapon varies extensively not only due to different ammunition and firing rate but also due to various manufacturers. Naturally, a question arises whether there is a specific physical characteristic of a weapon that can be identified to indicate the end of the useful life of the weapon. For example, is it possible to measure the diameter of the bore at the origin of rifling and identify when it is time to discard that barrel? Since the effectiveness of a weapon depends on the state of wear, it may be logical to assume that the bore dimension is the criterion to discard a weapon irrespective of ammunition or firing schedule. It is the objective of this section to discuss the bore dimension as a

criterion in light of the existing experimental data.

The bore shape may be symmetric or asymmetric after a number of rounds are fired. The accuracy of firing depends upon the true shape of the bore and not just the bore diameter at the origin of rifling. If the bore diameter is larger than the initial bore but symmetric in shape, probably the muzzle velocity will drop off. The consequence of a drop in muzzle velocity may be to hit a different target due to differences in exterior ballistics. However, the spread (or extreme spread) may be within tolerance especially on the targets which are nearer, such as 100 yards, in the present experimental program. If the bore shape is asymmetric but the diameter is almost the same as a new bore (initial), there is a possibility of large variations in the extreme spread even though the muzzle velocity is the same.

The experimental program involved the measurement of penetration of constant diameter gages near the origin of rifling as a function of number of rounds fired. The diameter of the various gages is shown in Table IV. Since the diameters of these gages vary from .2204 to .2234 inches, the maximum wear that can be measured at any one location is three-thousandths of an inch. There is a taper in the barrel bore near the origin of rifling. Since the M16A1 rifle is a 5.56mm (.219 inches) caliber weapon and the smallest gage diameter is slightly bigger than the nominal diameter of the bore, initially all of the measurements were made in the tapered section of the barrel and only a very few measurements were made (near the end of the test) in the constant diameter section of the barrel after significant erosion took place. It may be impossible to sample the diameter of a tapered section of the barrel and judge the status of the barrel irrespective of manufacturer, user, ammunition, or firing rate.

Since the constant diameter gages reach the tapered section of the axisymmetric barrel and possibly later (due to wear) asymmetric barrels, there is at most a line-contact between the gage and the barrel. The line-contact is not satisfactory for obtaining consistent or accurate results because it is possible to shift the axis of the gage from the axis of the gun barrel.

The penetration of Gage 3, as a function of number of rounds fired, is shown in Figure 83 for C1, C2, C4, C5, C7, and C8. All of these firings include various rates of fire but with only M193 ball propellant. In general, the penetration is higher with a high rate of fire for any given number of rounds fired. There is no specific criterion or penetration which can be determined from this figure to condemn the gun barrel for the useful life of barrels mentioned in Table IV for ball propellant. Each barrel has its own penetration reading for the useful life assigned in Table IV. The similar penetration data for other weapons (contractors) and other gages are shown in Figures 84 through 94. The trend remained the same as for Gage 3 and contractor 'C' (Figure 83).

TABLE IV

DIAMETER OF VARIOUS GAGES

Gage Number	Gage Diameter In Inches	Gage Length In Inches
1	.2204	15.960
2	.2206	16.003
3	.2208	16.003
4	.2210	16.003
5	.2212	16.003
6	.2218	16.012
7	.2223	16.020
8	.2228	16.011
9	.2234	16.014

It is important to look at the region where the gage measurements yield erosion. This is shown in Figure 95 with appropriate bore dimensions. Since the groove diameter of rifling is 0.2235 inches and also the diameter of the bore is 0.2235 inches at the origin of rifling, the Gage #9, which has a diameter of 0.2234 inches, should penetrate the bore to the origin of rifling initially. The constant diameter of the land of rifling (0.219 + .001) starts 0.1054 inches from the origin of rifling. The difference in diameter from the largest to the smallest gage is 0.003 inches. Therefore, a gage should not enter the full depth land area initially (new rifle). However, consider the distance of the gage end from the spacer initially (Table LXII, GM2, Reference 1):

Gage #	1	2	3	4	5	6	7	8	9
Distance	6.26	6.48	6.56	6.69	6.74	6.90	6.97	6.98	6.99

The difference in distance between Gages #1 and #9 is 0.73 inches. However, it was concluded above that the difference in distance, initially, can be a maximum of 0.1054 inches. Therefore, it is apparent that the measurements of Gages #1 through #5 are in error, probably due to the gages entering the constant rifling region of the bore. Other related data from Reference 1 indicates that the gages penetrated less as firing progressed which would be the opposite of expected results.

VI. RECOMMENDATIONS

From the definition of ideal gage and from the analysis of the experimental data for its consistency and accuracy, it is reluctantly suggested that Gage #6 may be used for the measurement of barrel erosion and ultimately to indicate when to discard that barrel. The word, "reluctantly"is used due to lack of a unique approach in the selection of a gage. Following the gage selection, it is logical to look for a specific criterion in order to abandon the barrel at the end of the useful life. It may not be possible to say that a barrel is obsolete when a gage, such as #6, penetrates a certain distance irrespective of manufacturer, ammunition, firing rate, and (cumulative) number of rounds fired even though erosion is a function of all of these quantities.

To determine the feasibility of such a concept or criterion, the resulting curves of rounds-fired versus penetration are shown in Figures 84 thru 94 for each manufacturer and for each gage (number 3 thru 6). There are six curves in each figure representing all three rates of fire but only M193 ball ammunition. For example, C_1, C_2, C_4, C_5, C_7, and C_8 are included in one figure. The penetration of the gage varies extensively from weapon to weapon especially near the end of the useful life of the barrel. Therefore, such a plot is unlikely to yield any specific criteria or even single dimension (penetration) for each manufacturer. The plotting symbols 1 and 2 represent the firing rate of 20 rounds per minute. Similarly,

the symbols 3 and 4, and 5 and 6 denote the firing rates of 60 and 100 rounds per minute, respectively. The trend is larger penetrations (more erosion) for higher rates of fire for the same total number of rounds fired. Therefore, even a round counter wouldn't be helpful to indicate the end of the useful life in practice.

Since the erosion increases and the useful life of the weapon decreases with increase in rate of fire, it is logical to expect the spread in results of the percentage of useful life versus penetration to be minimum. Such results are shown in Figures 96 thru 107 for each manufacturer and for each gage (the percentage of life versus penetration is shown individually in Figures 108 thru 161 for gages 4, 5, and 6). The resulting curves are spaced out even farther than the curves of number-of-rounds versus penetration. However, the trend is opposite to that of rounds versus penetration. It is therefore concluded that the useful life is not a linear function of firing rate, but a nonlinear one. The useful life of the weapon may be approximated as inversely proportional to the two-third power of the firing rate (the exponent for contractor 'C' is 0.63). The firing rate has not been used extensively as a parameter in wear predictions possibly because it is variable and unpredictable in actual combat conditions; nevertheless, it is recommended that this parameter should be used at least in laboratory controlled experiments in order to formulate a successful model of wear. It may be possible to construct a statistical or empirical function to simulate the average firing rate in combat conditions.

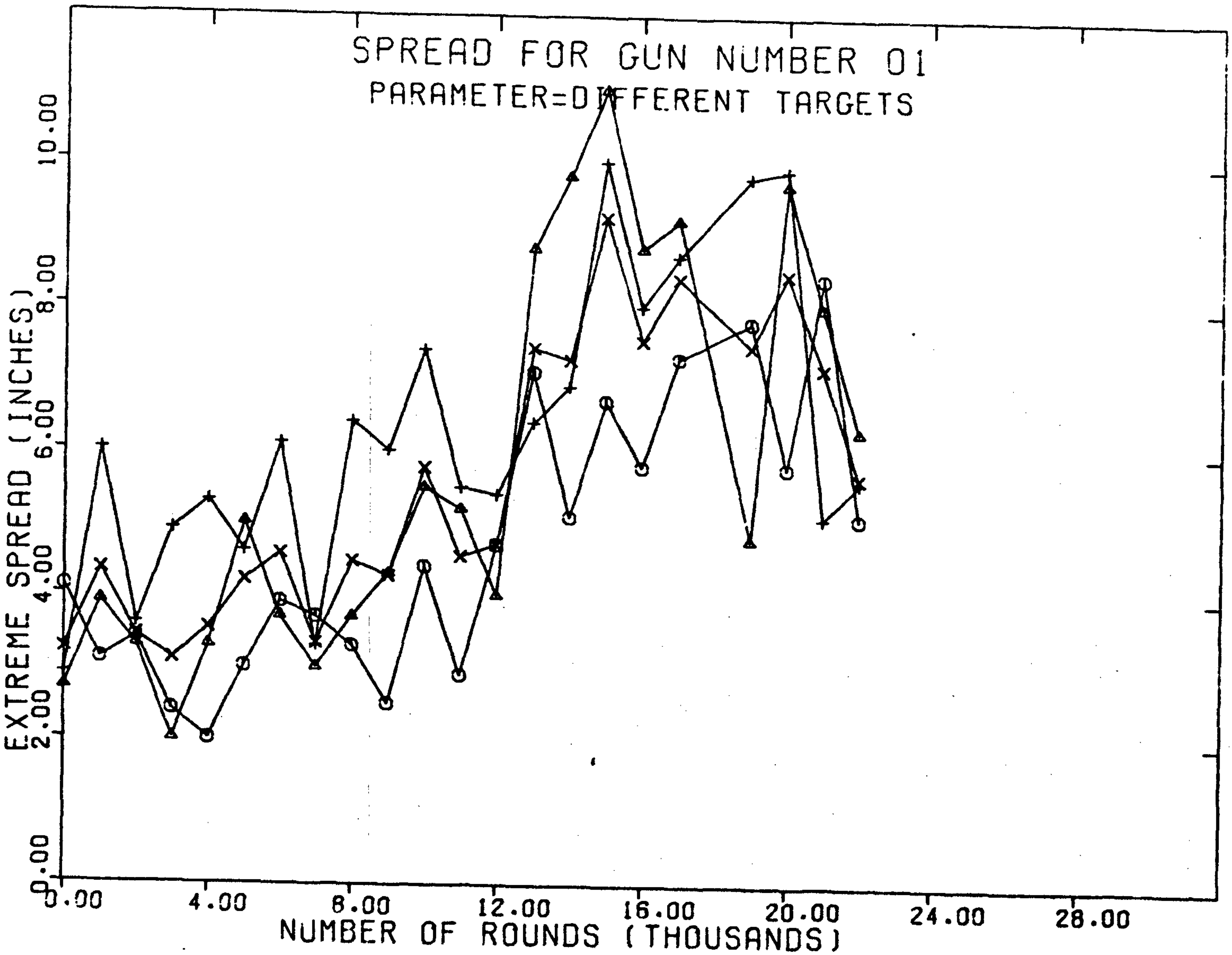


FIGURE 1 - Variation of Extreme Spread due to Gun Number 1

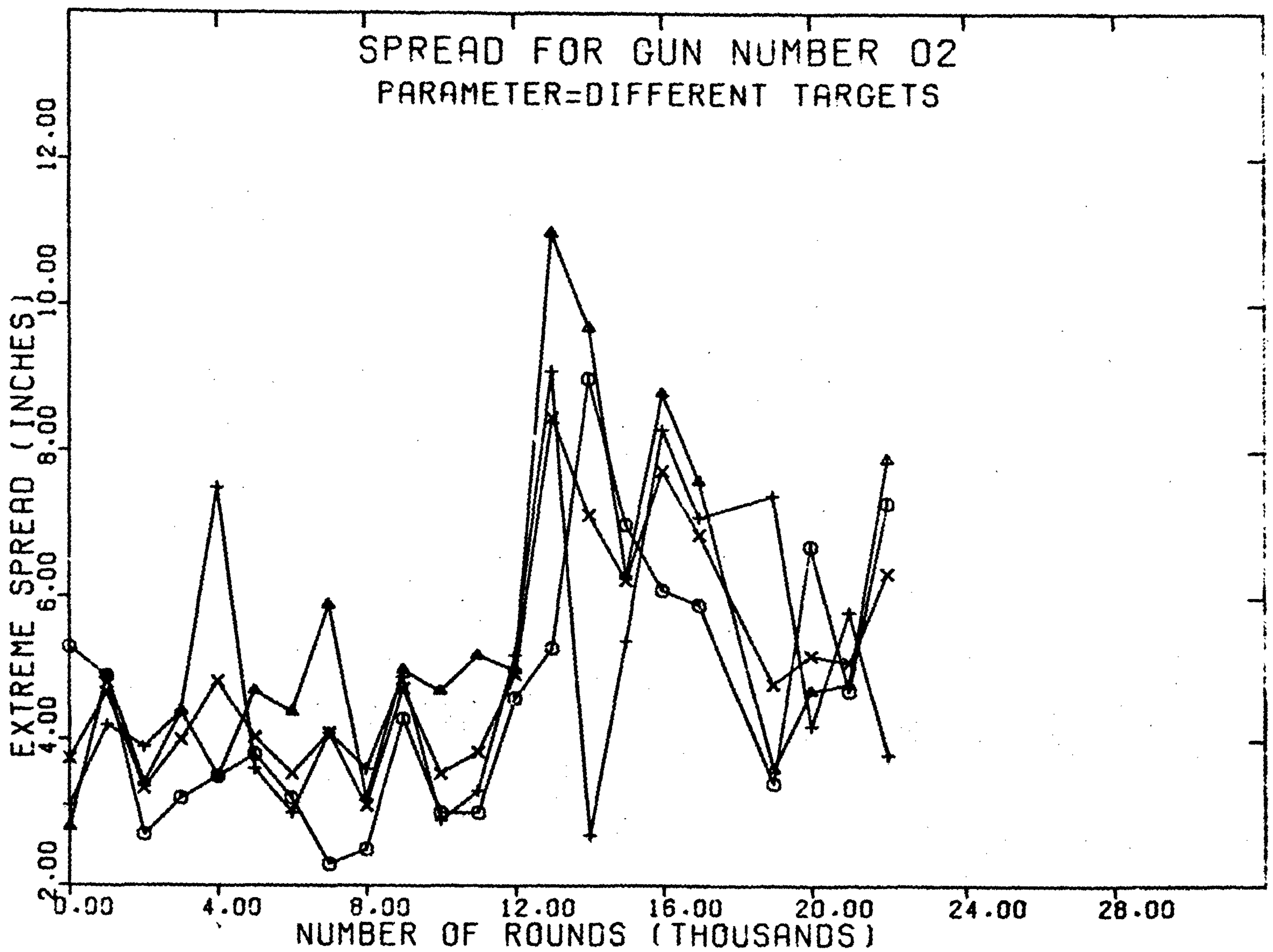


FIGURE 2 - Variation of Extreme Spread due to Gun Number 2

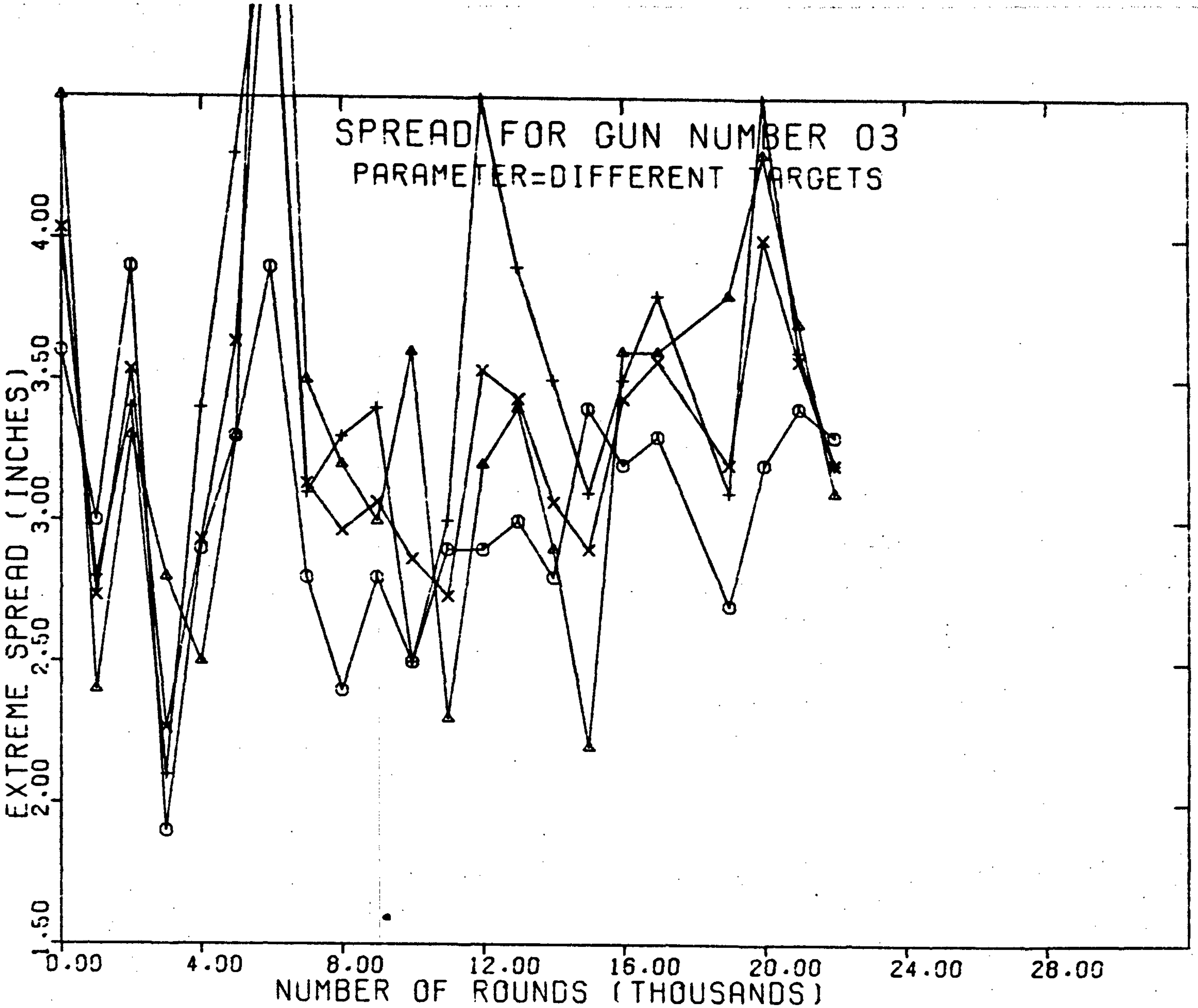


FIGURE 3 - Variation of Extreme Spread due to Gun Number 3

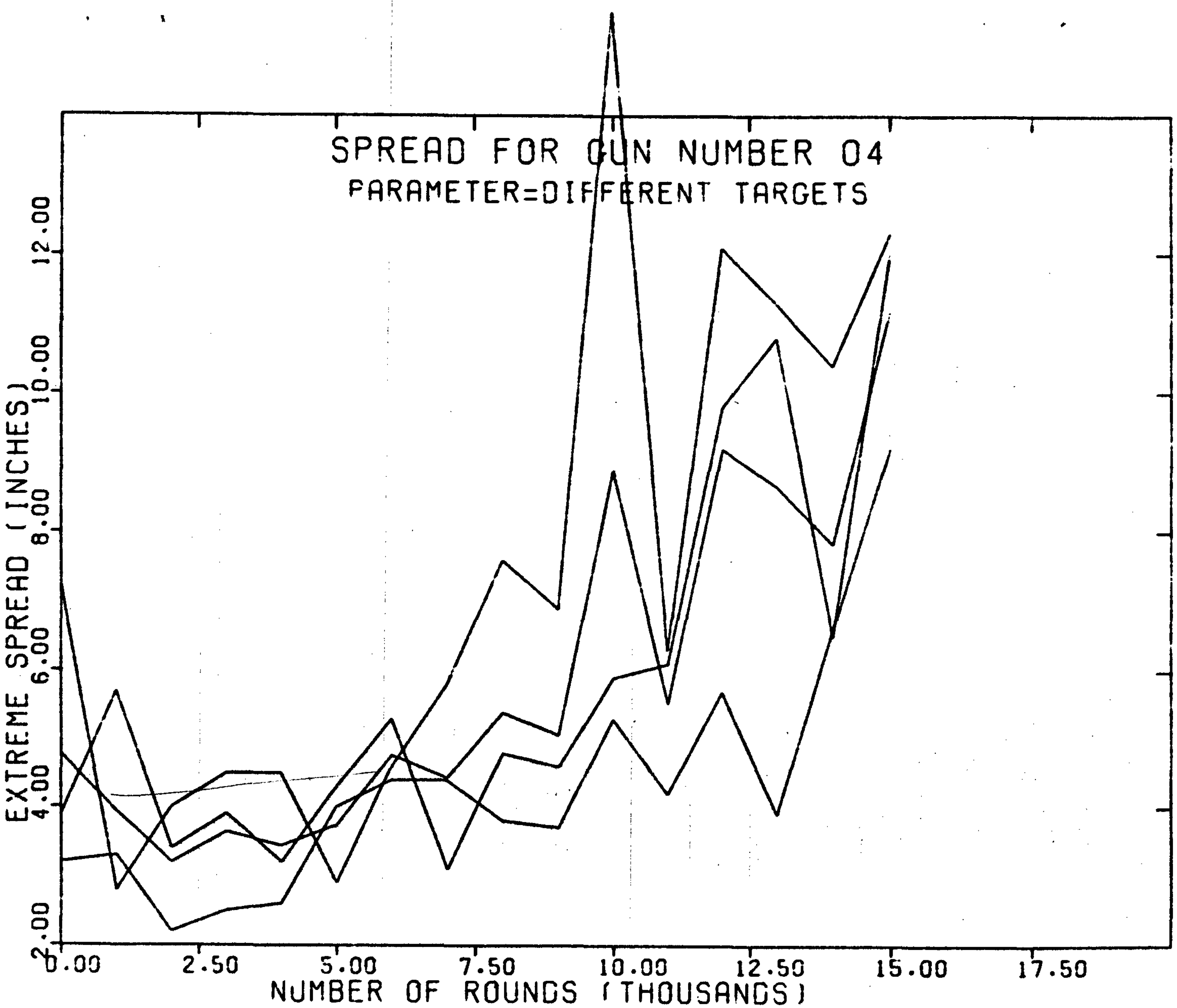


FIGURE 4 - Variation of Extreme Spread due to Gun Number 4

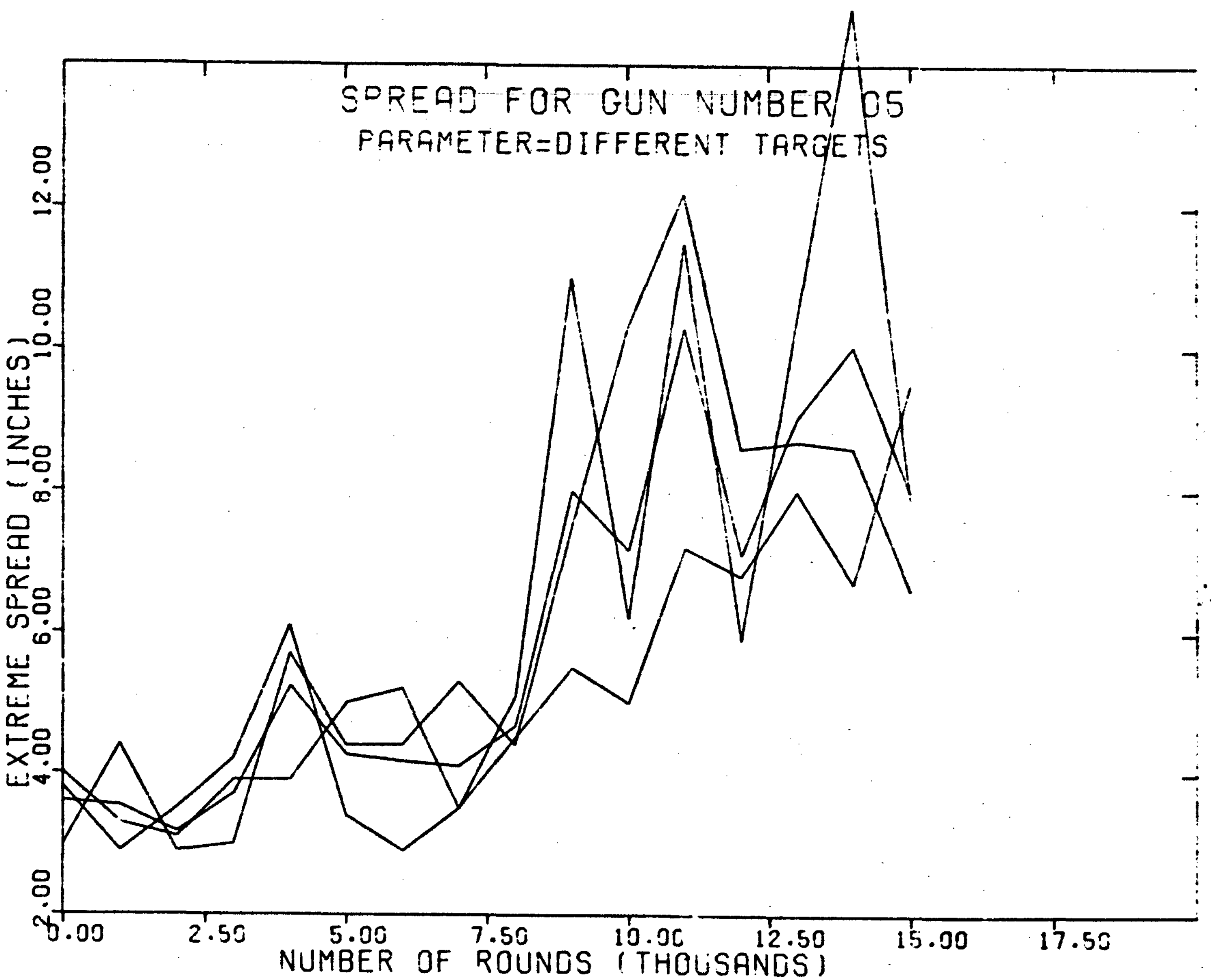


FIGURE 5 - Variation of Extreme Spread due to Gun Number 5

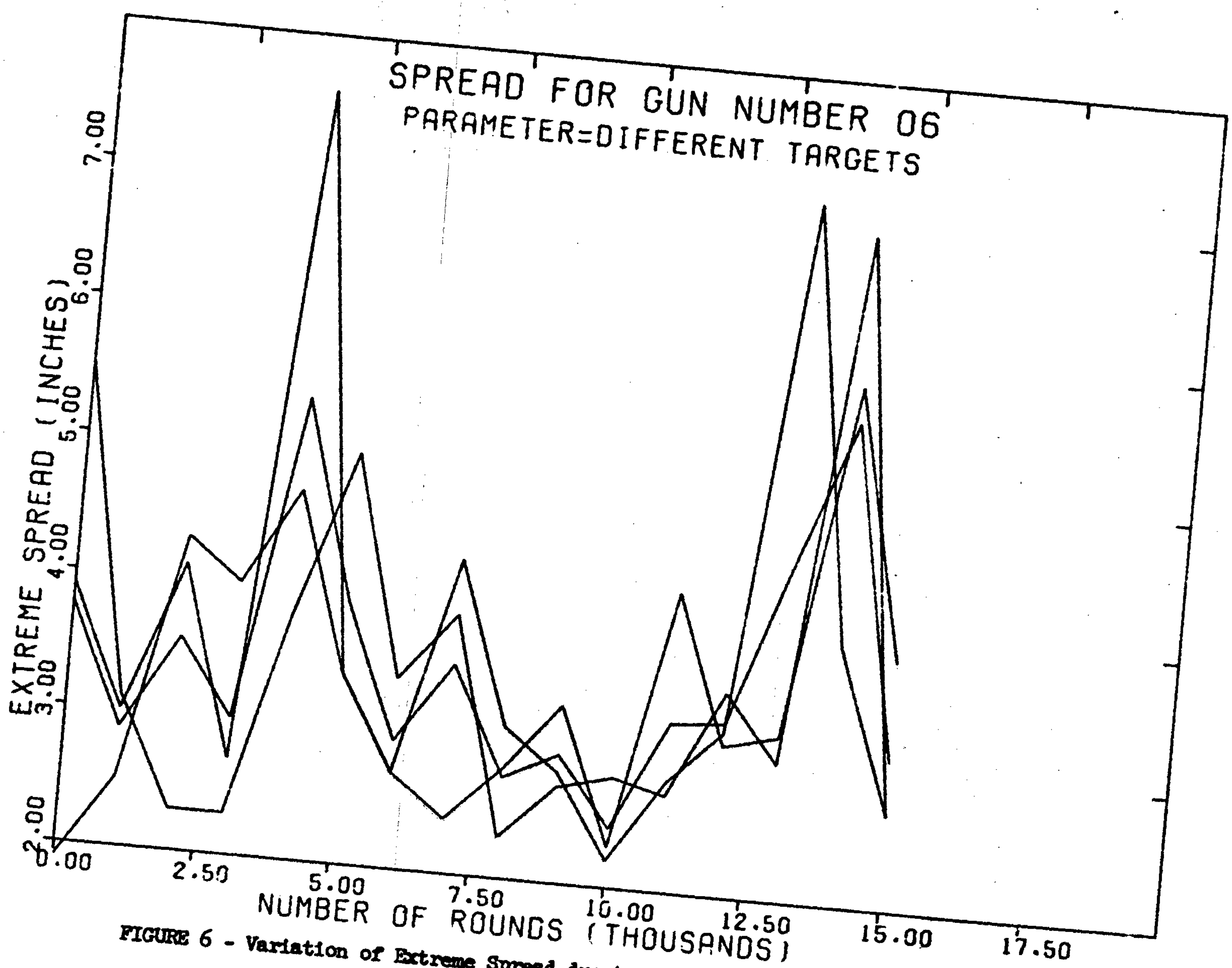


FIGURE 6 - Variation of Extreme Spread due to Gun Number 6

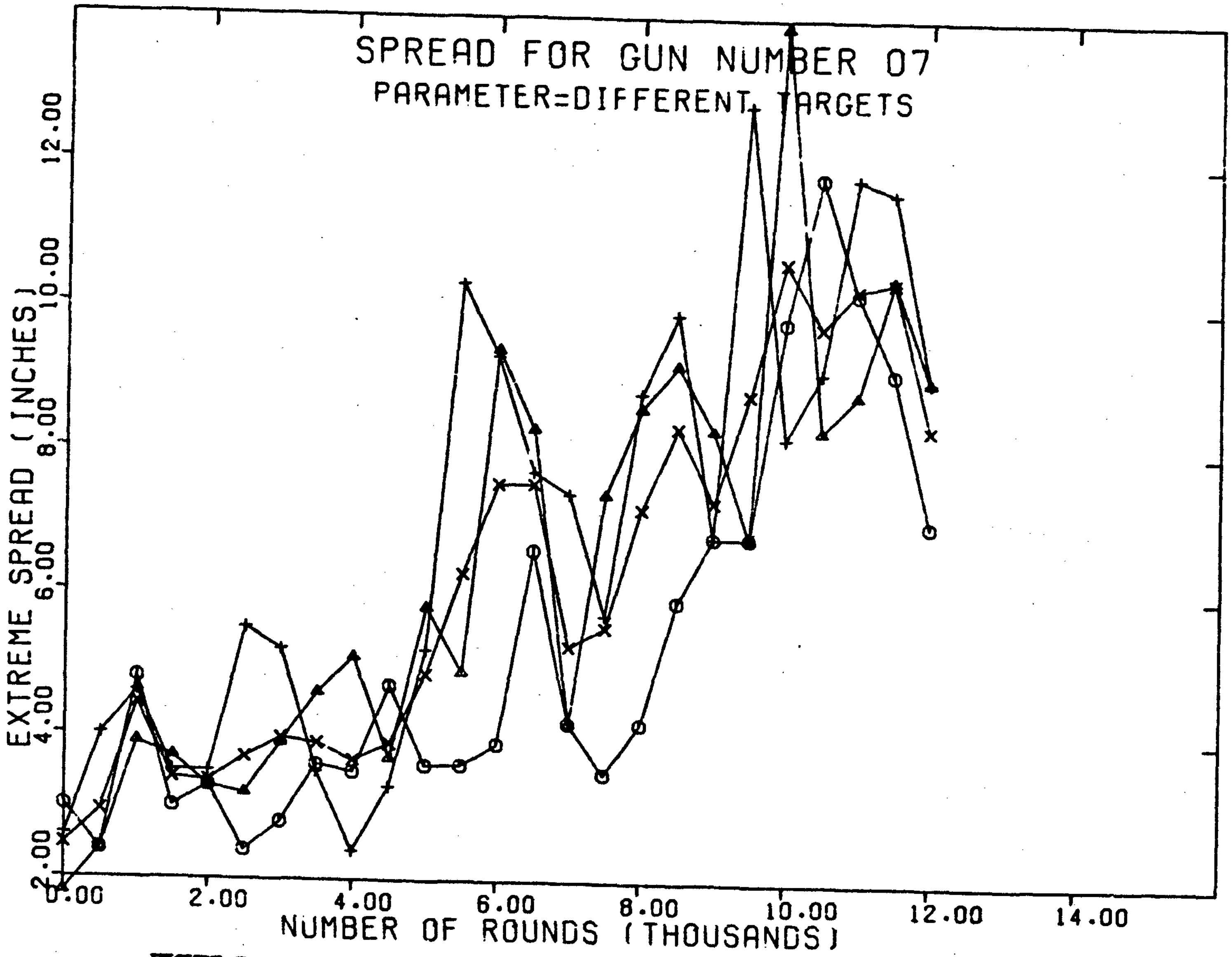


FIGURE 7 - Variation of Extreme Spread due to Gun Number 7

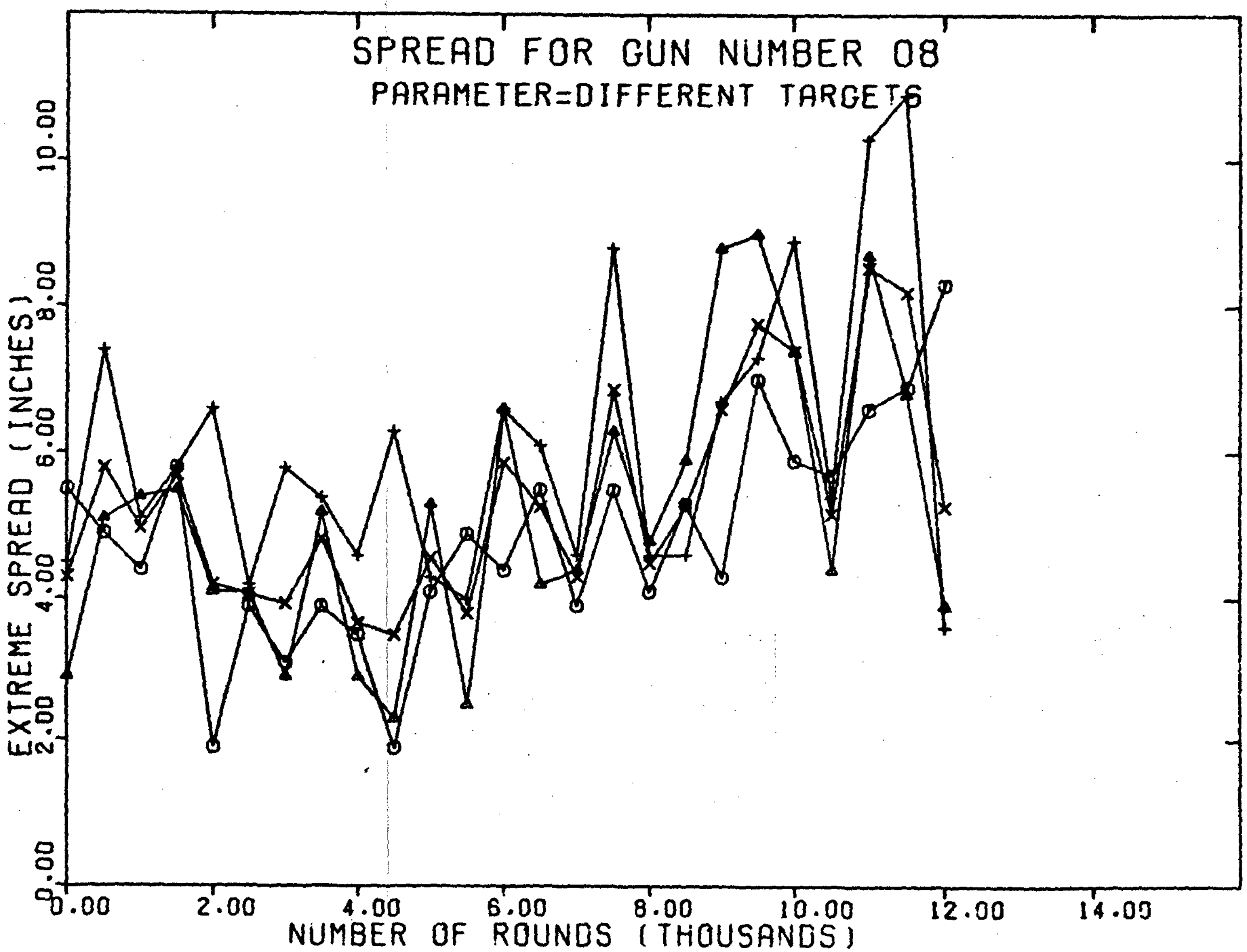


FIGURE 8 - Variation of Extreme Spread due to Gun Number 8

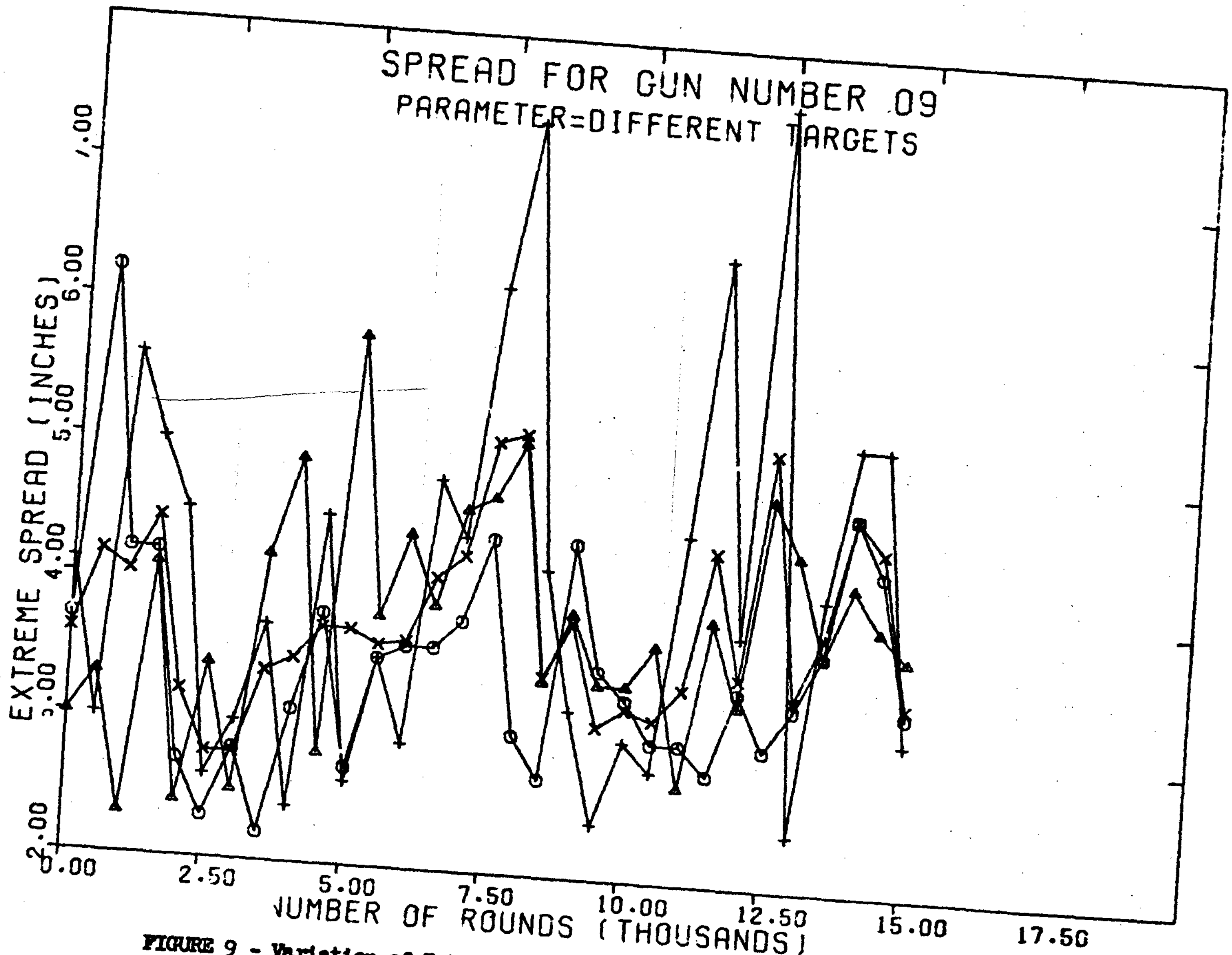


FIGURE 9 - Variation of Extreme Spread due to Gun Number 9

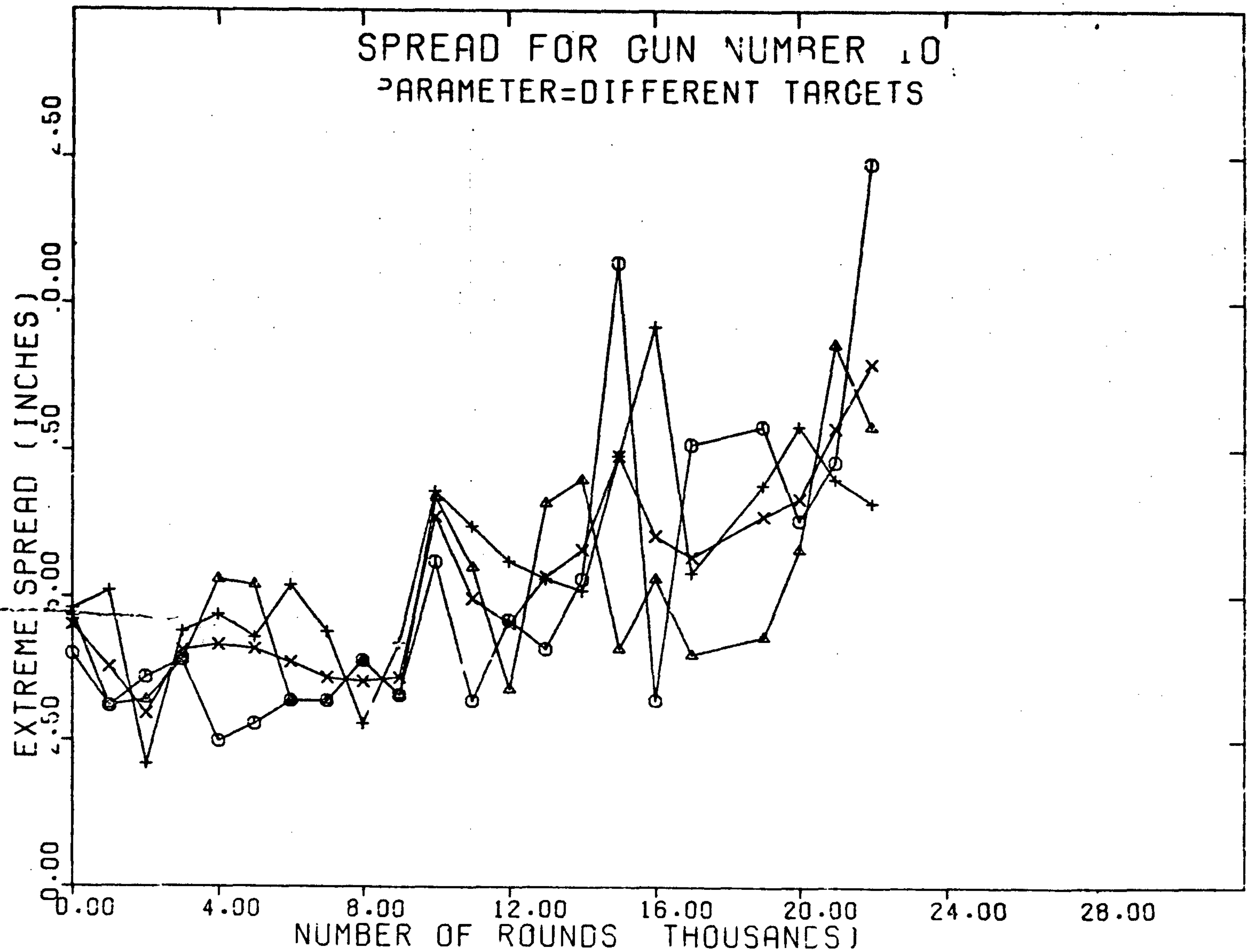


FIGURE 10 - Variation of Extreme Spread due to Gun Number 10

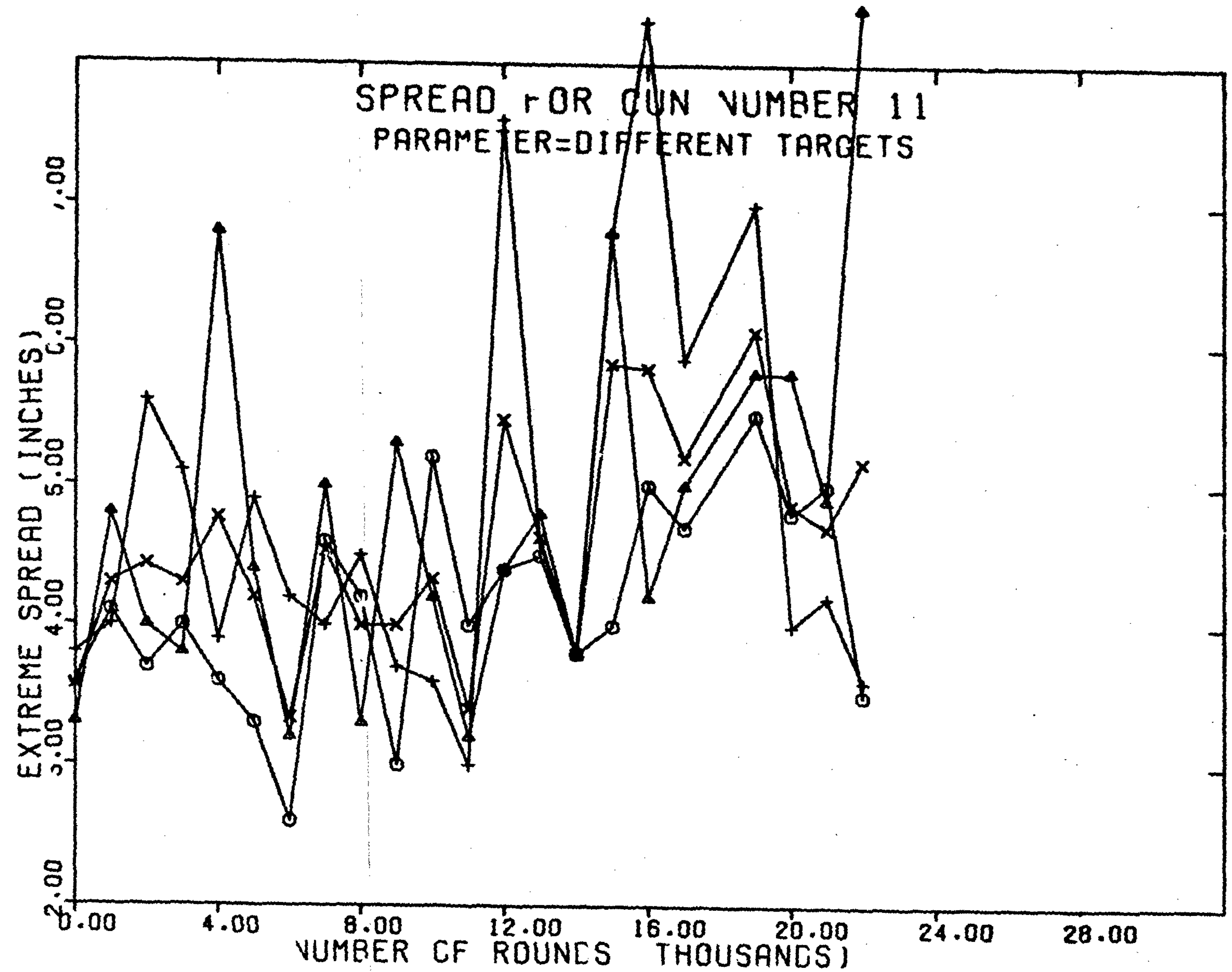


FIGURE 11 - Variation of Extreme Spread due to Gun Number 11

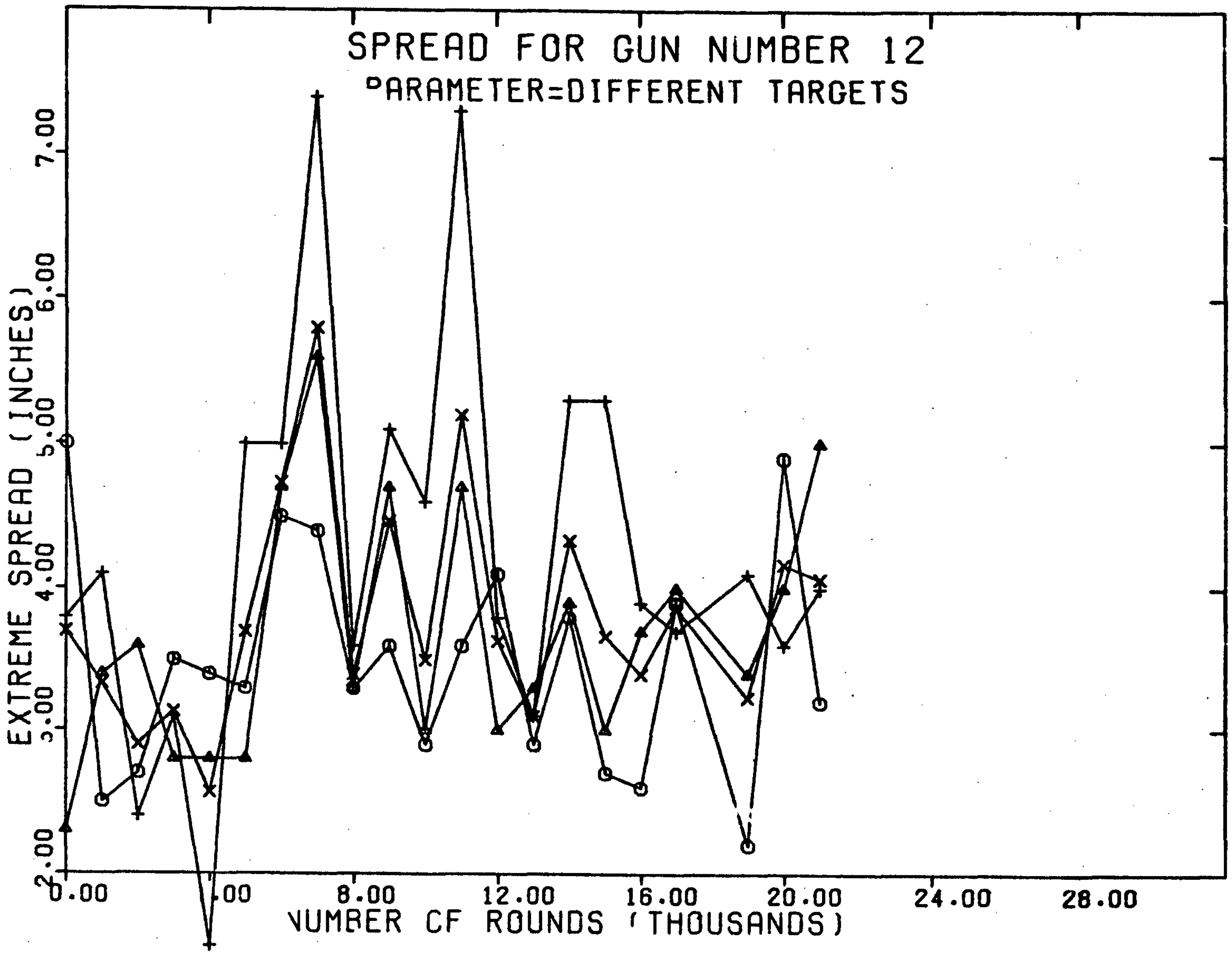


FIGURE 12 - Variation of Extreme Spread due to Gun Number 12

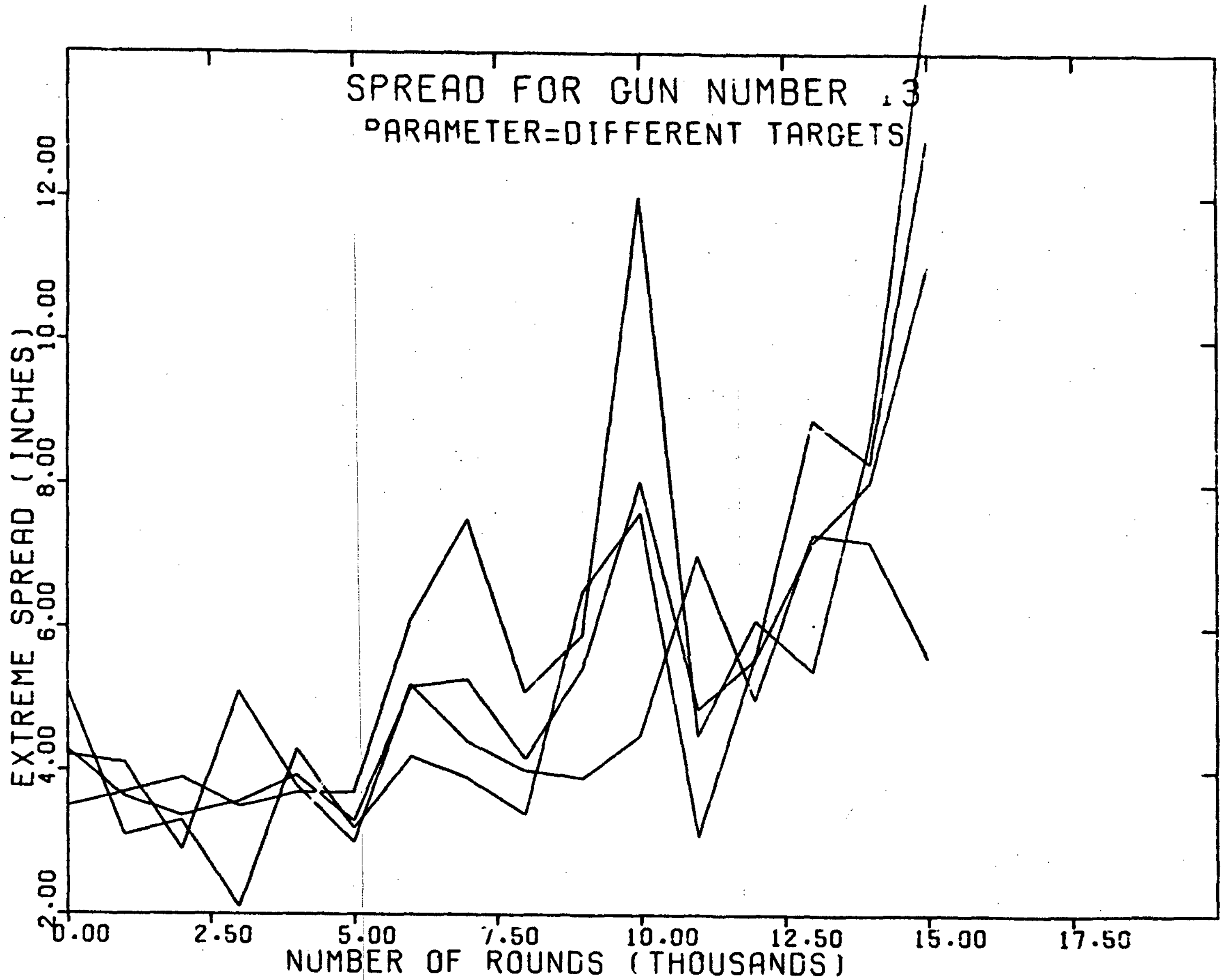


FIGURE 13 - Variation of Extreme Spread due to Gun Number 13

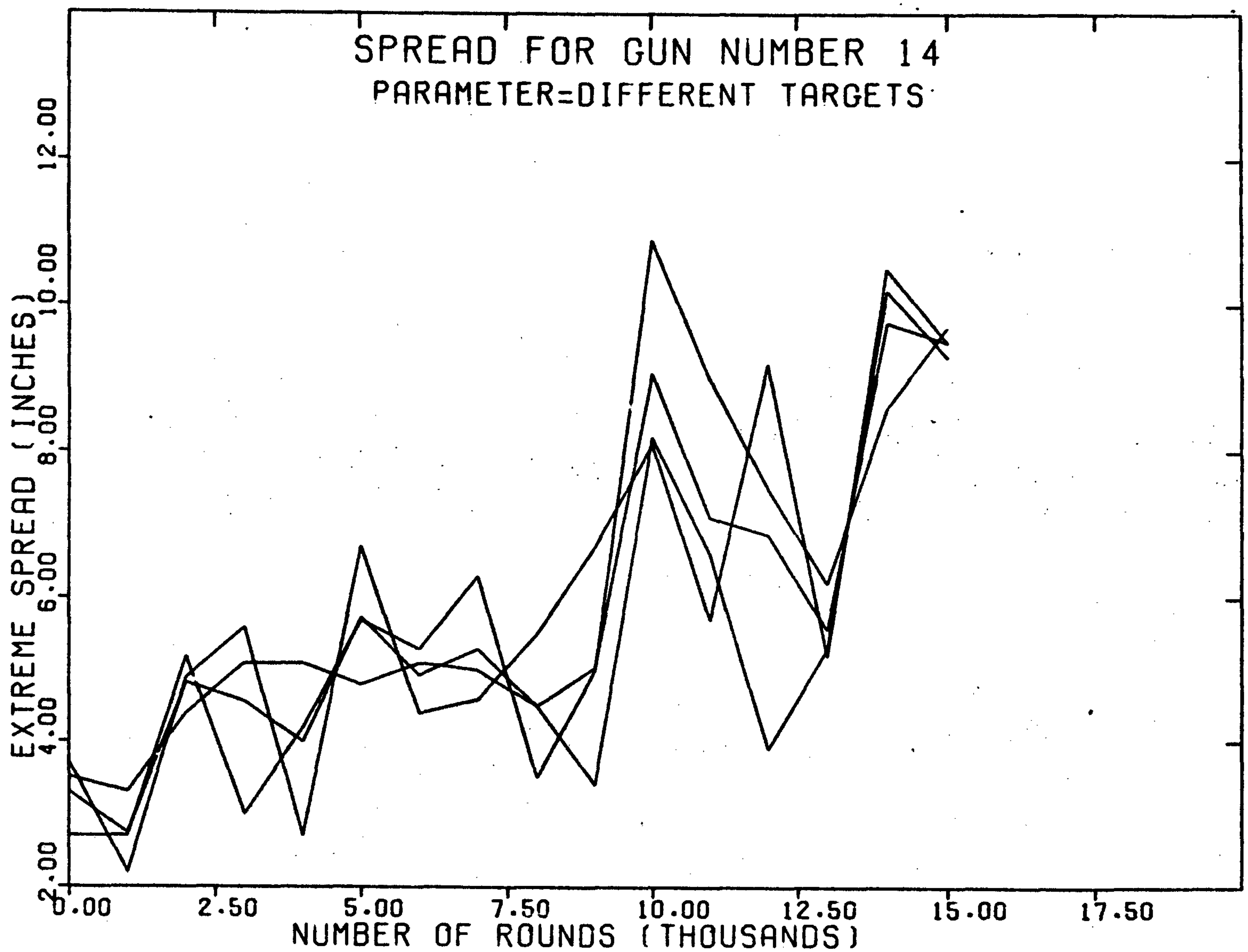


FIGURE 14 - Variation of Extreme Spread due to Gun Number 14

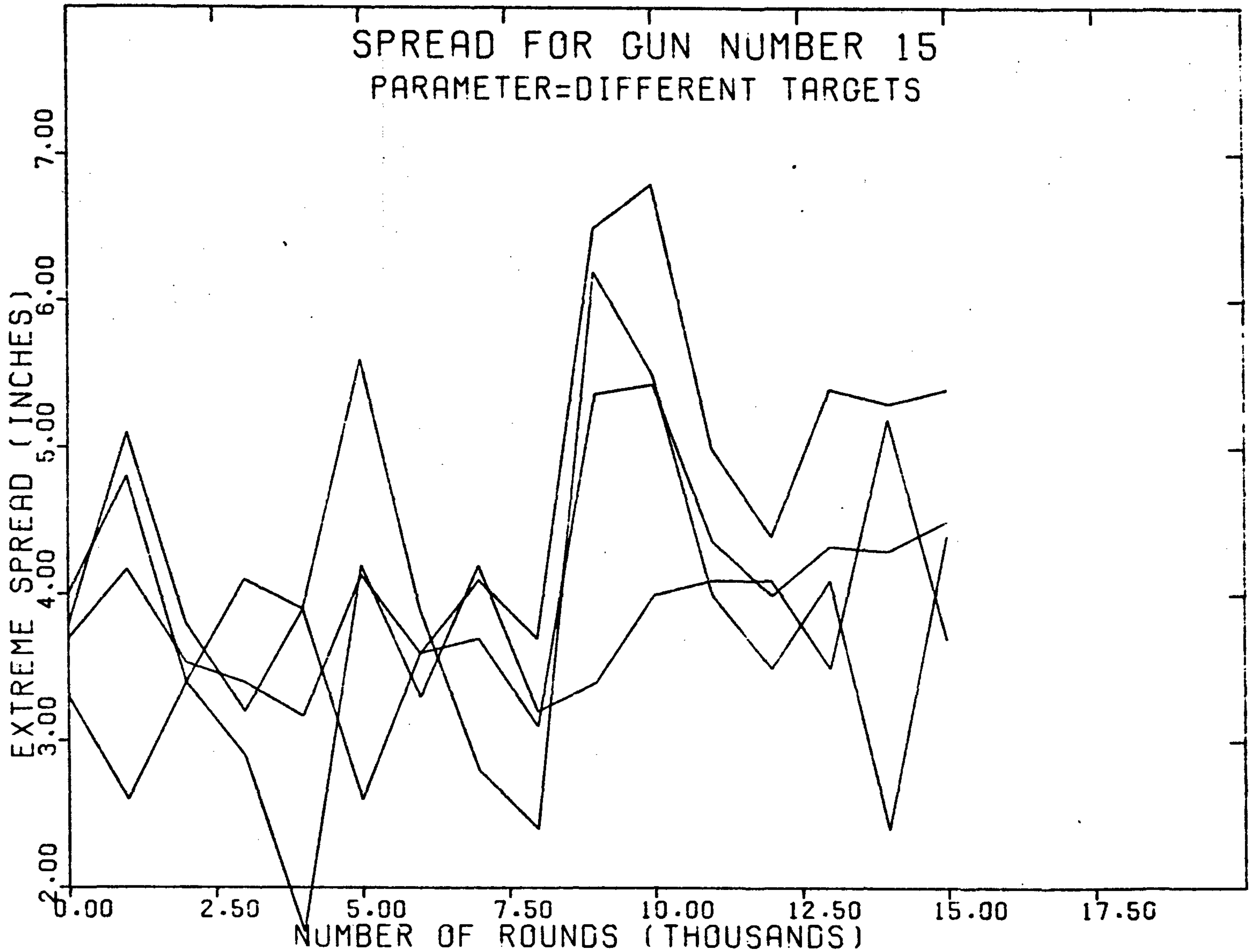
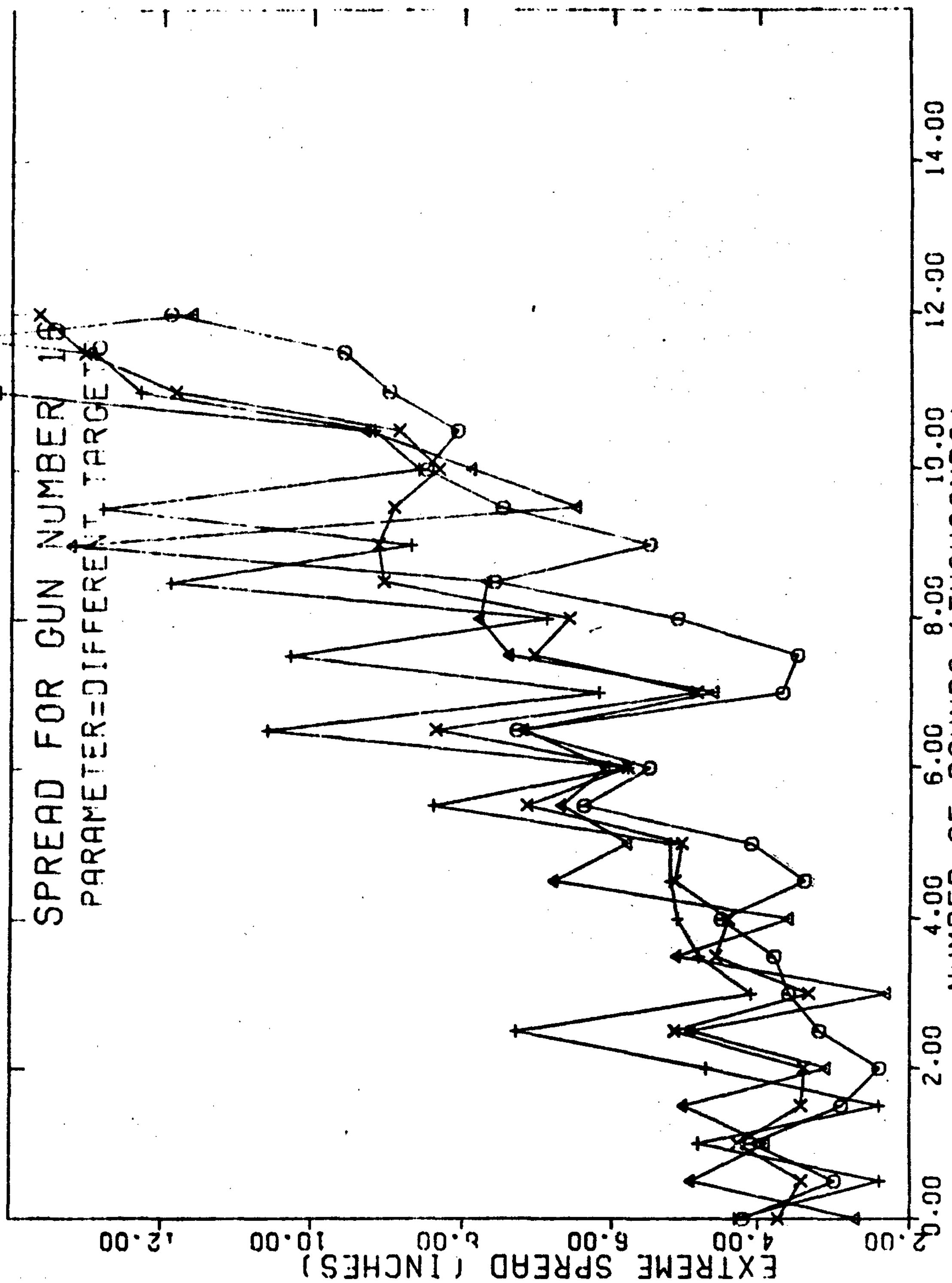


FIGURE 15 - Variation of Extreme Spread due to Gun Number 15


SPREAD FOR GUN NUMBER 15
PARAMETER=DIFFERENT TARGETS
EXTREME SPREAD (INCHES)
NUMBER OF ROUNDS (THOUSANDS)
2.00
4.00
6.00
8.00
10.00
12.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00

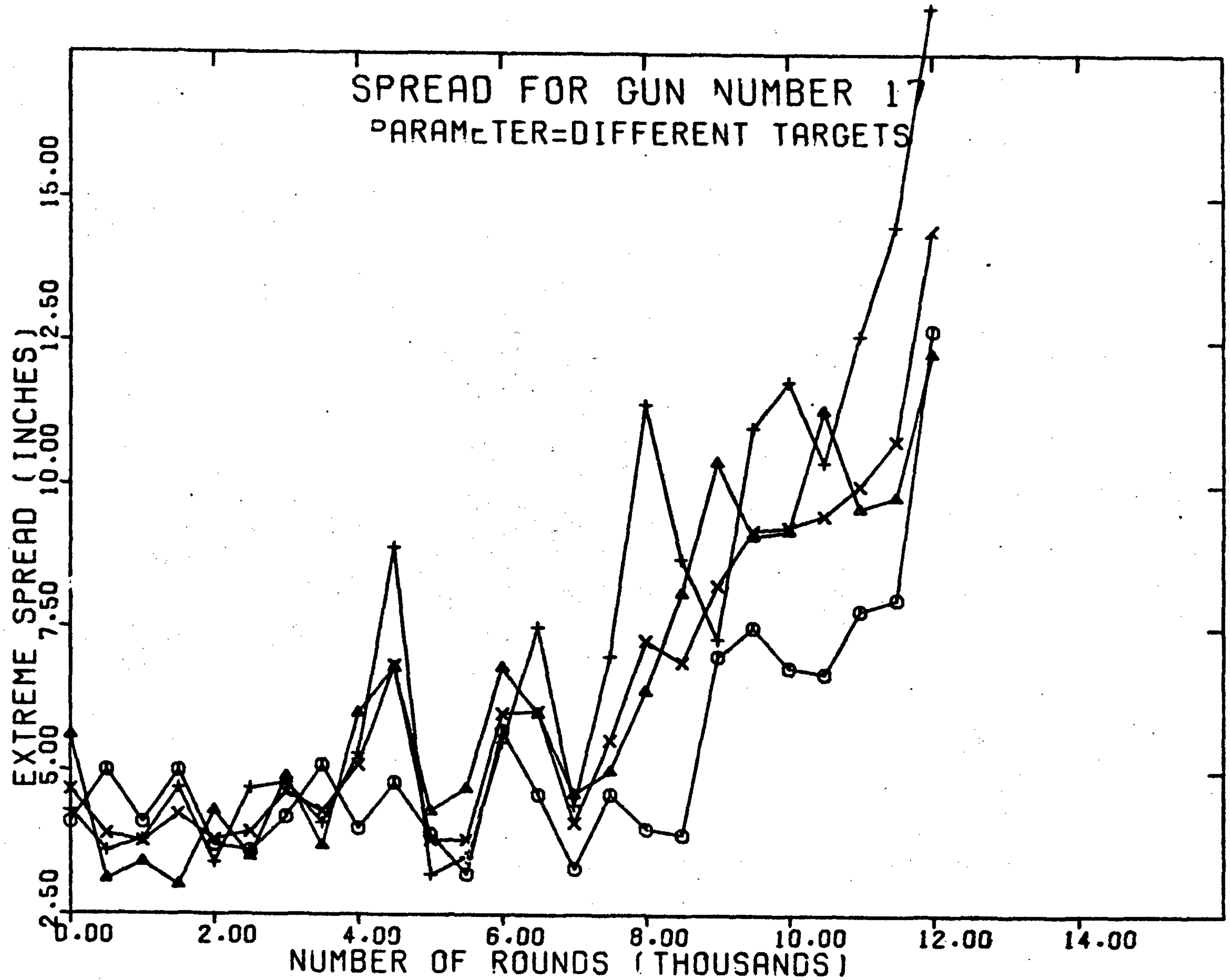


FIGURE 18 - Variation of Extreme Spread due to Gun Number 17

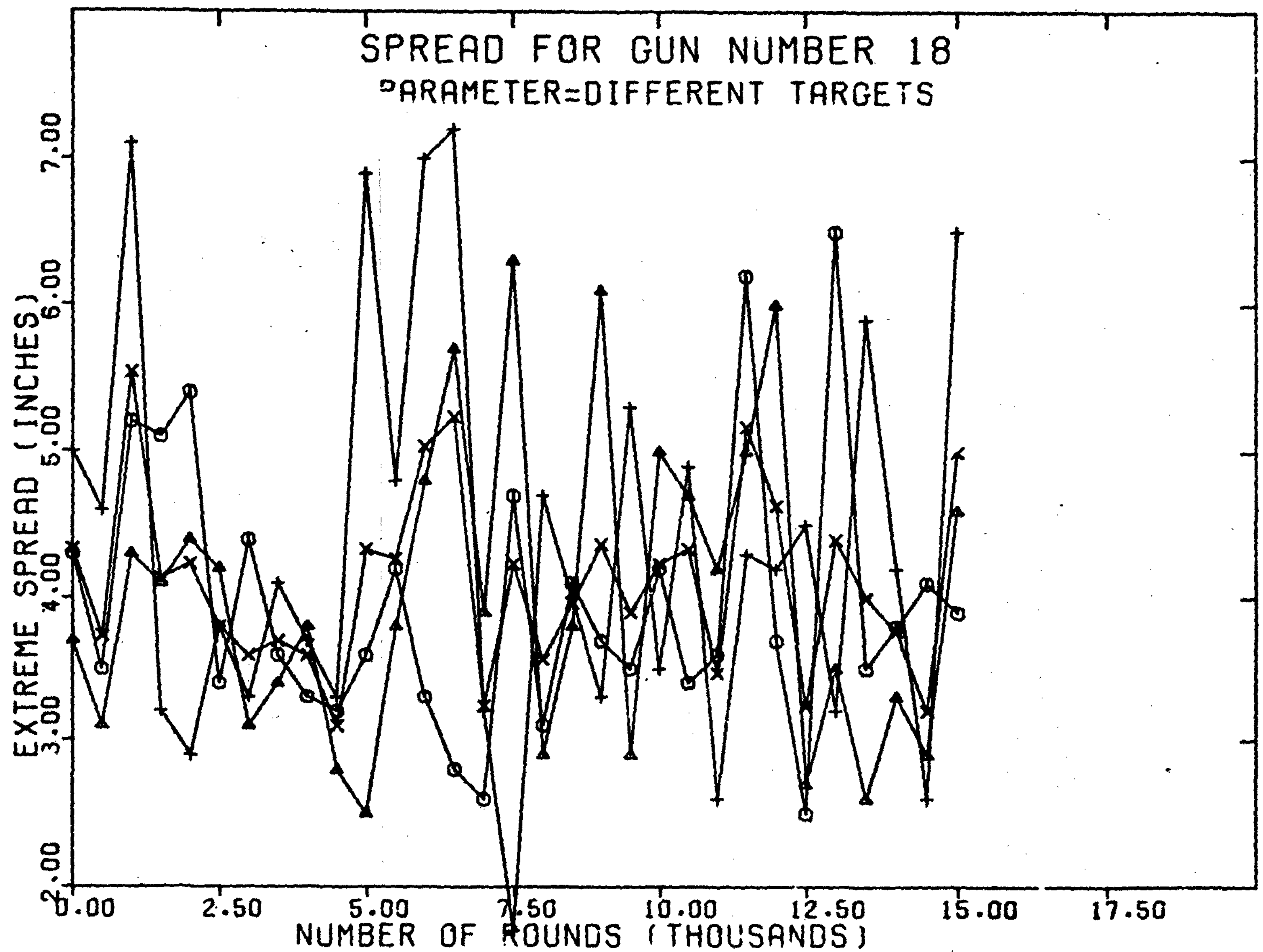


FIGURE 18 - Variation of Extreme Spread due to Gun Number 18

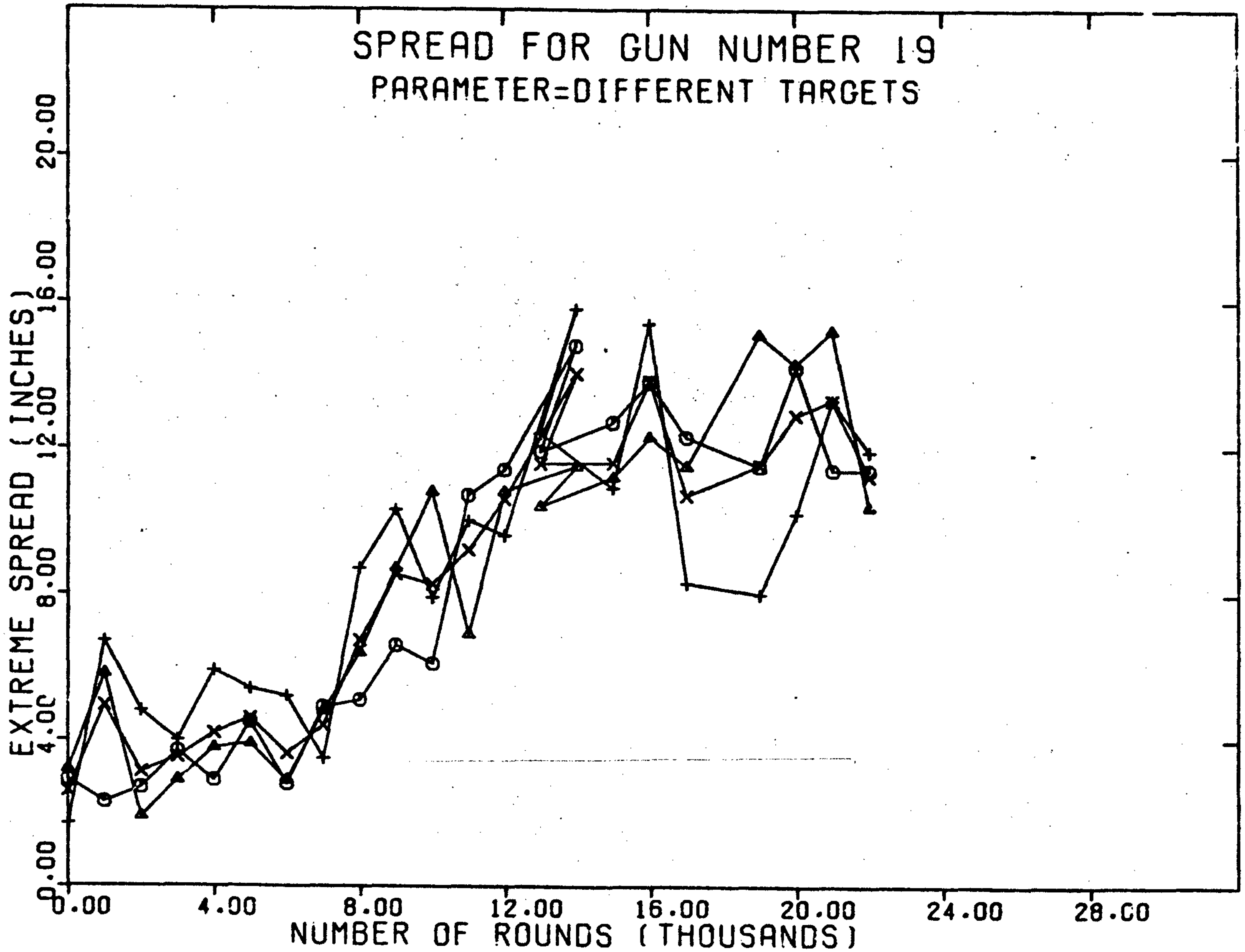


FIGURE 19 - Variation of Extreme Spread due to Gun Number 19

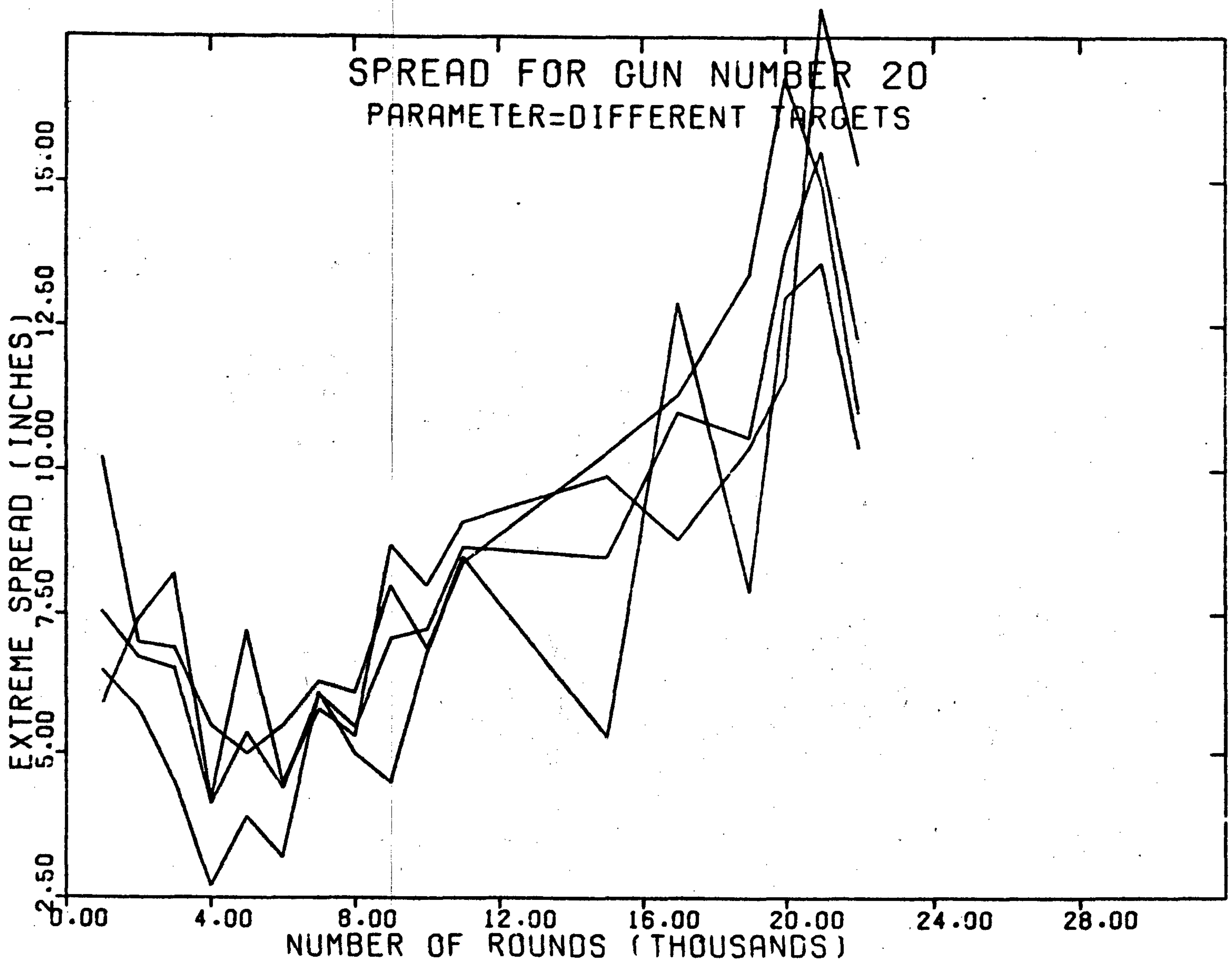


FIGURE 20 - Variation of Extreme Spread due to Gun Number 20

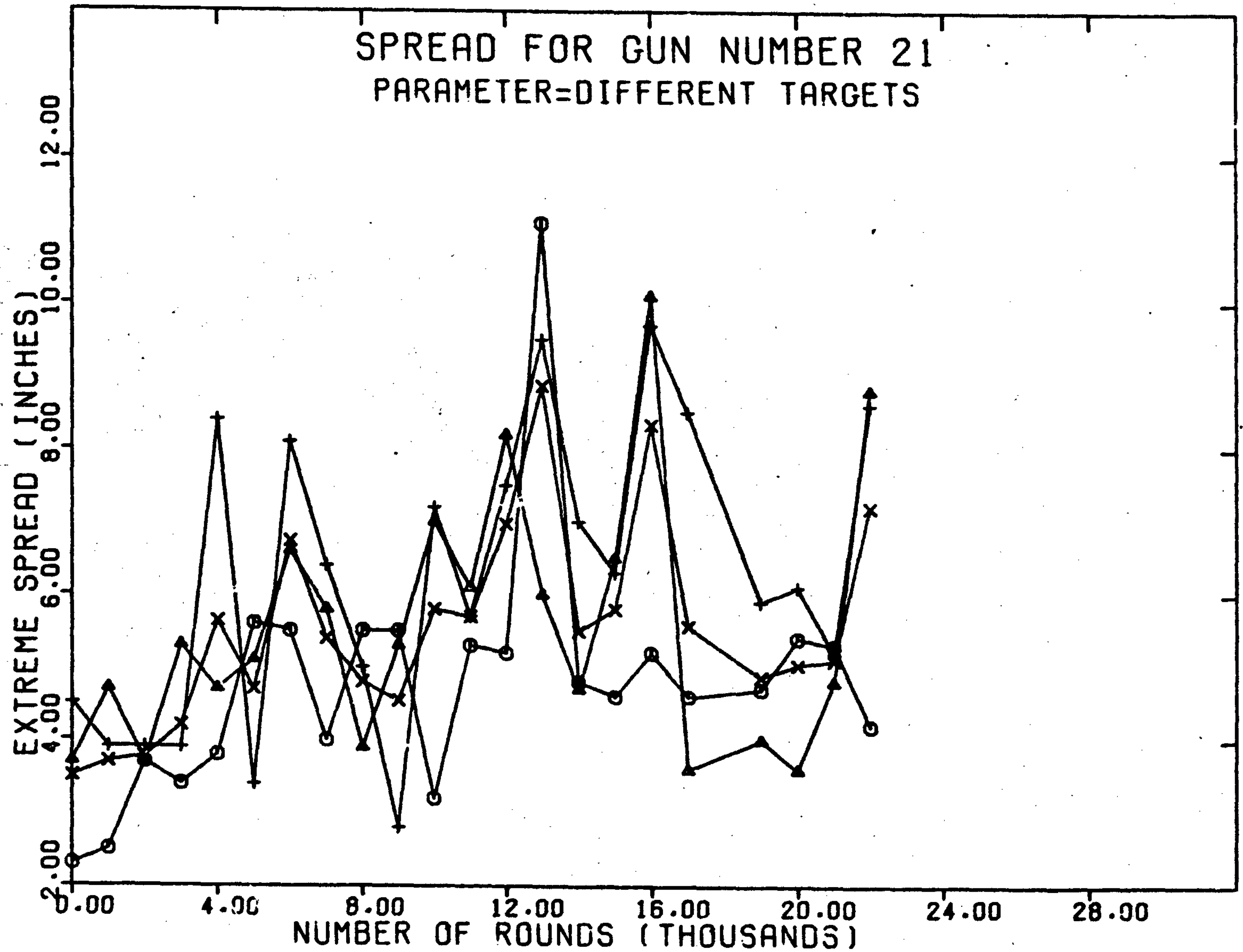


FIGURE 21 - Variation of Extreme Spread Due to Gun Number 21

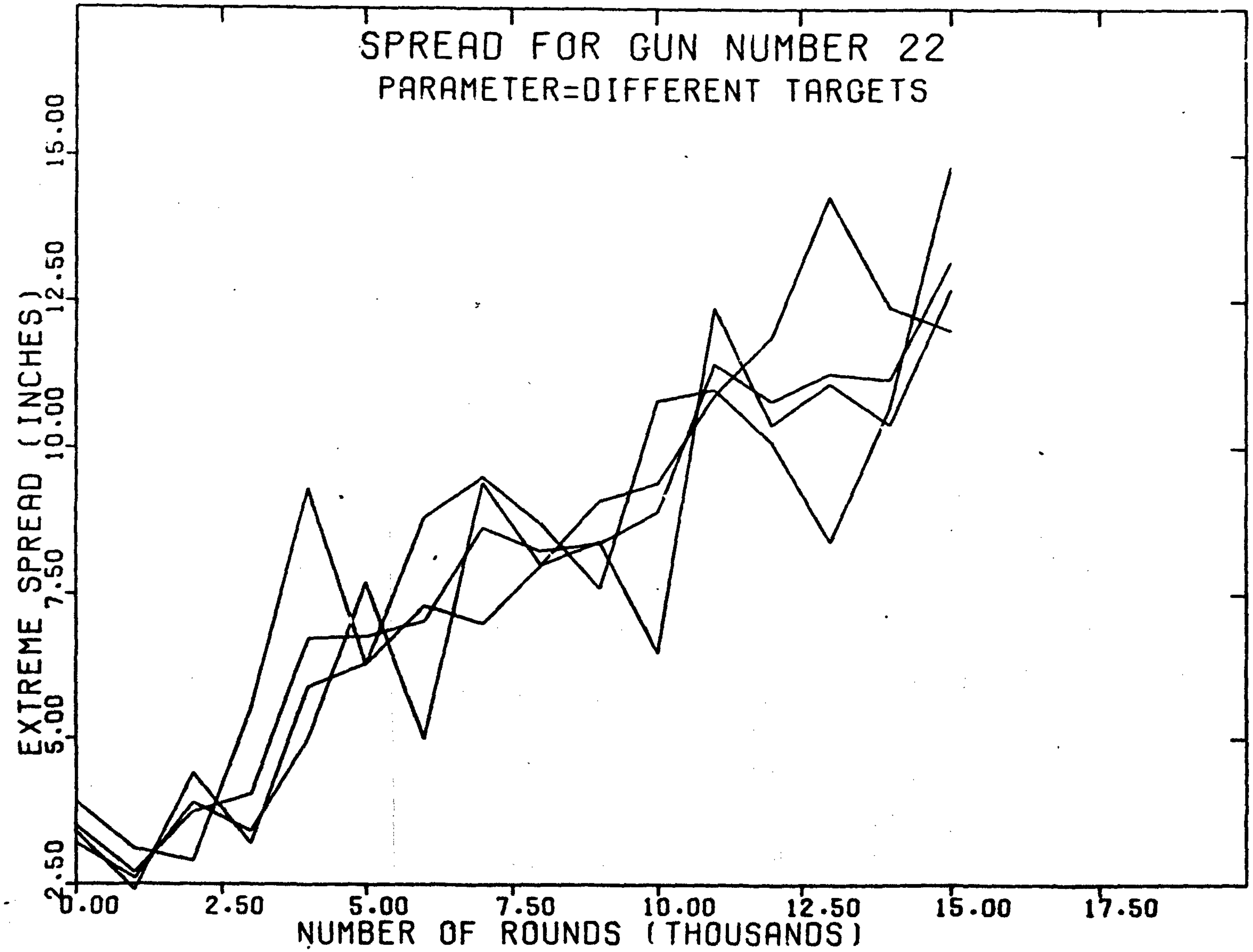
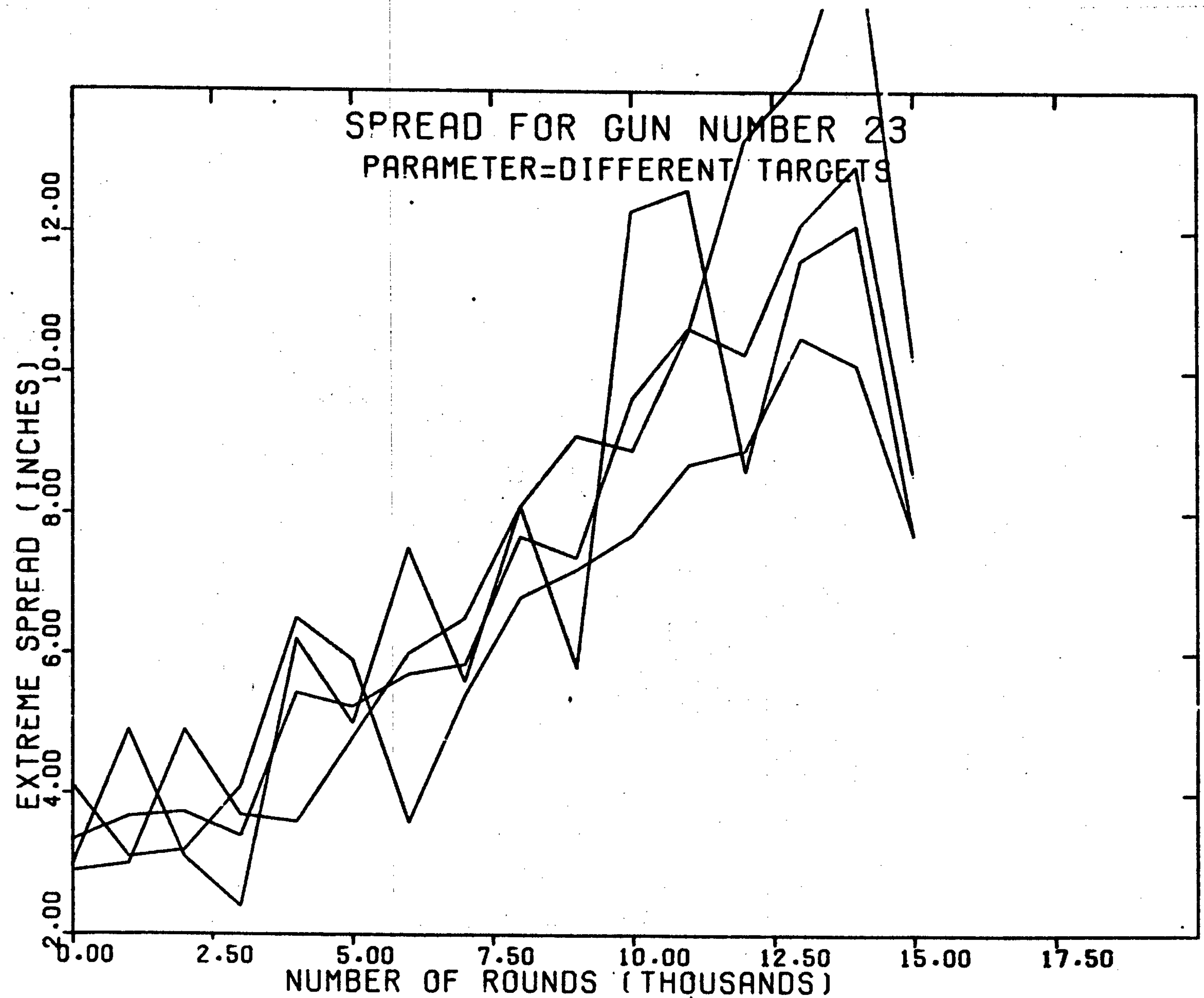


FIGURE 22 - Variation of Extreme Spread due to Gun Number 22



VFIGURE 23 - Variation of Extreme Spread due to Gun Number 23

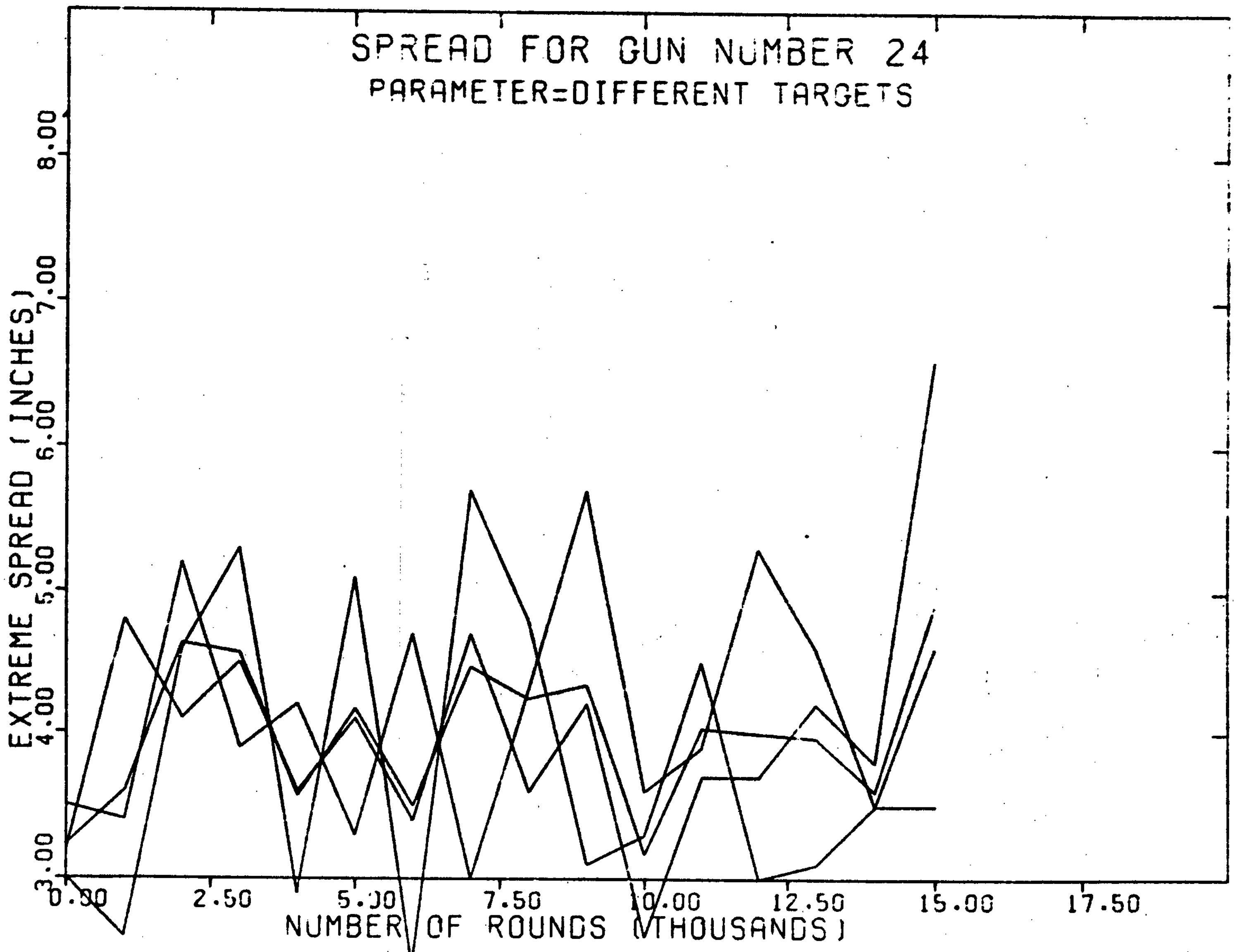


FIGURE 24. Variation of Extreme Spread due to Gun Number 24

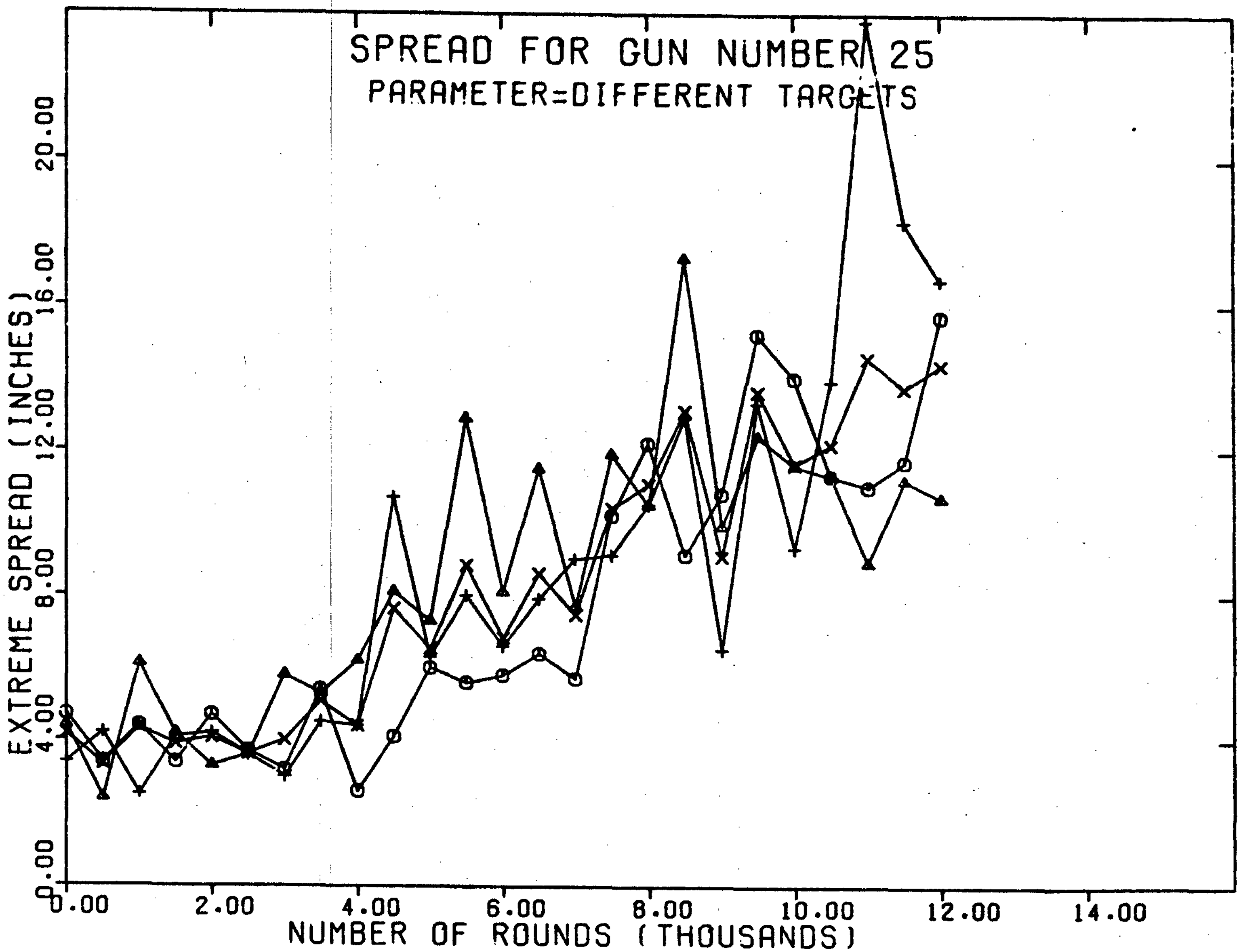


FIGURE 25 - Variation of Extreme Spread due to Gun Number 25

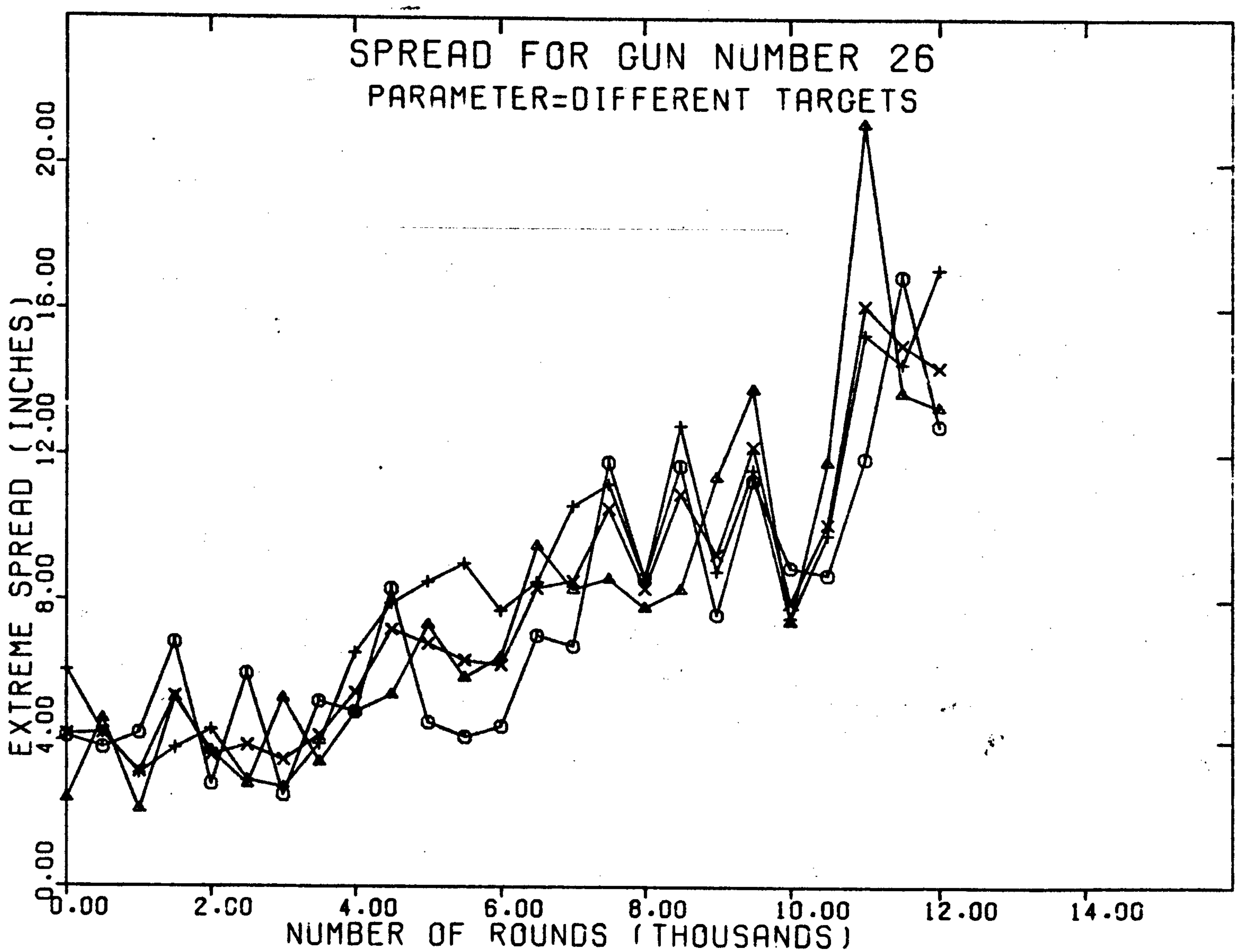


FIGURE 26 - Variation of Extreme Spread due to Gun Number 26

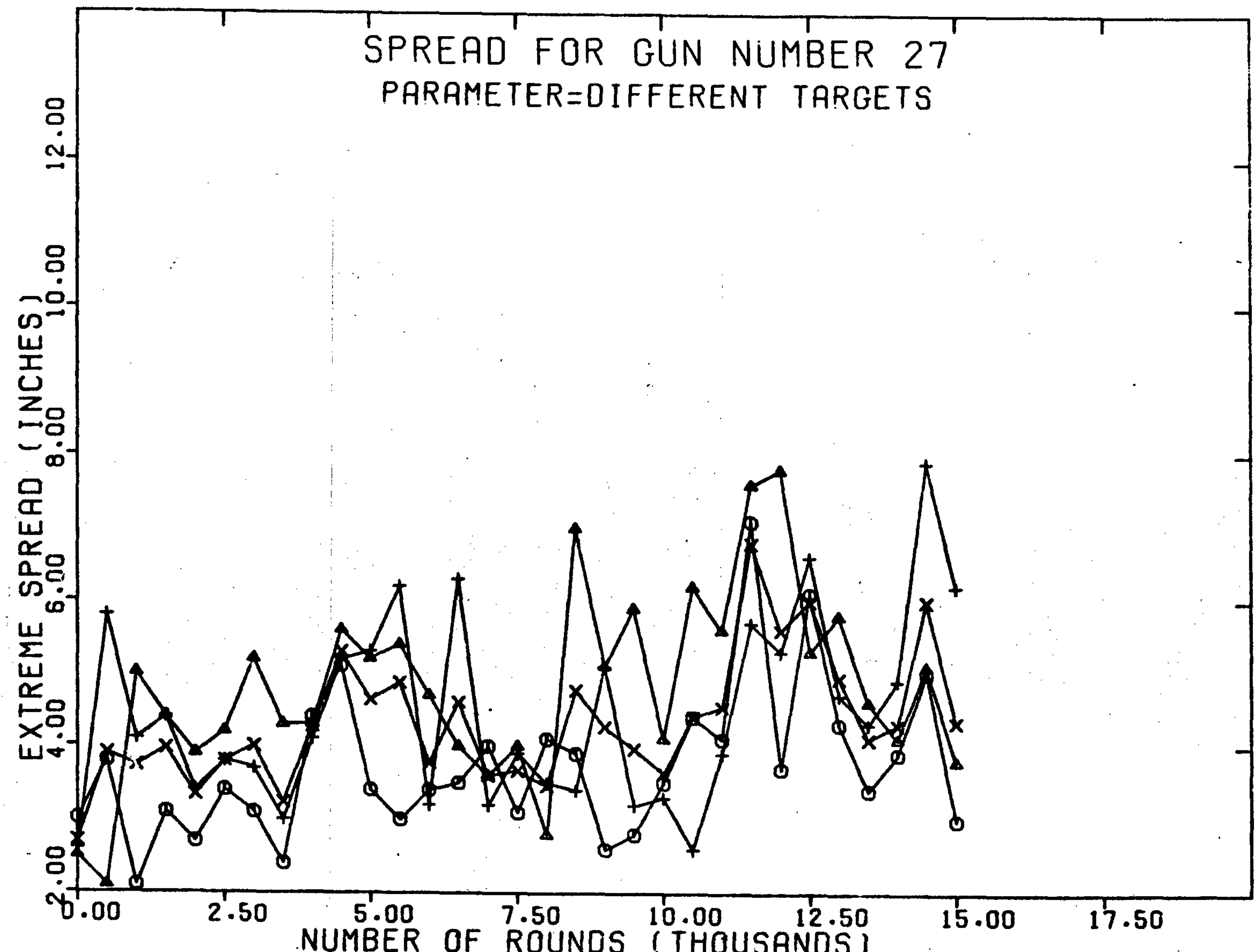
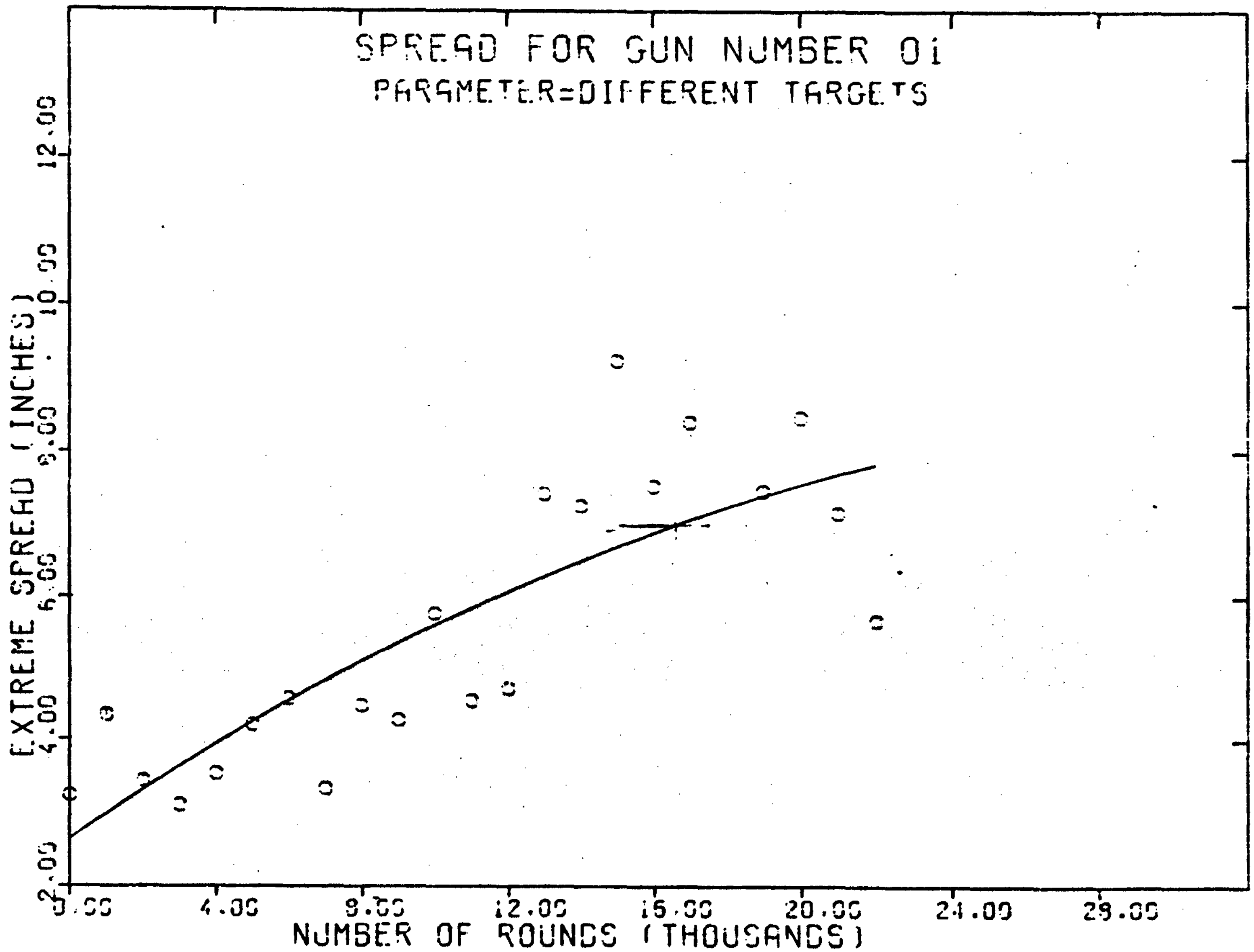


FIGURE 27 - Variation of Extreme Spread due to Gun Number 27


SPREAD FOR GUN NUMBER 01
PARAMETER=DIFFERENT TARGETS
EXTREME SPREAD (INCHES)
2.00
4.00
6.00
8.00
10.00
12.00
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
NUMBER OF ROUNDS (THOUSANDS)

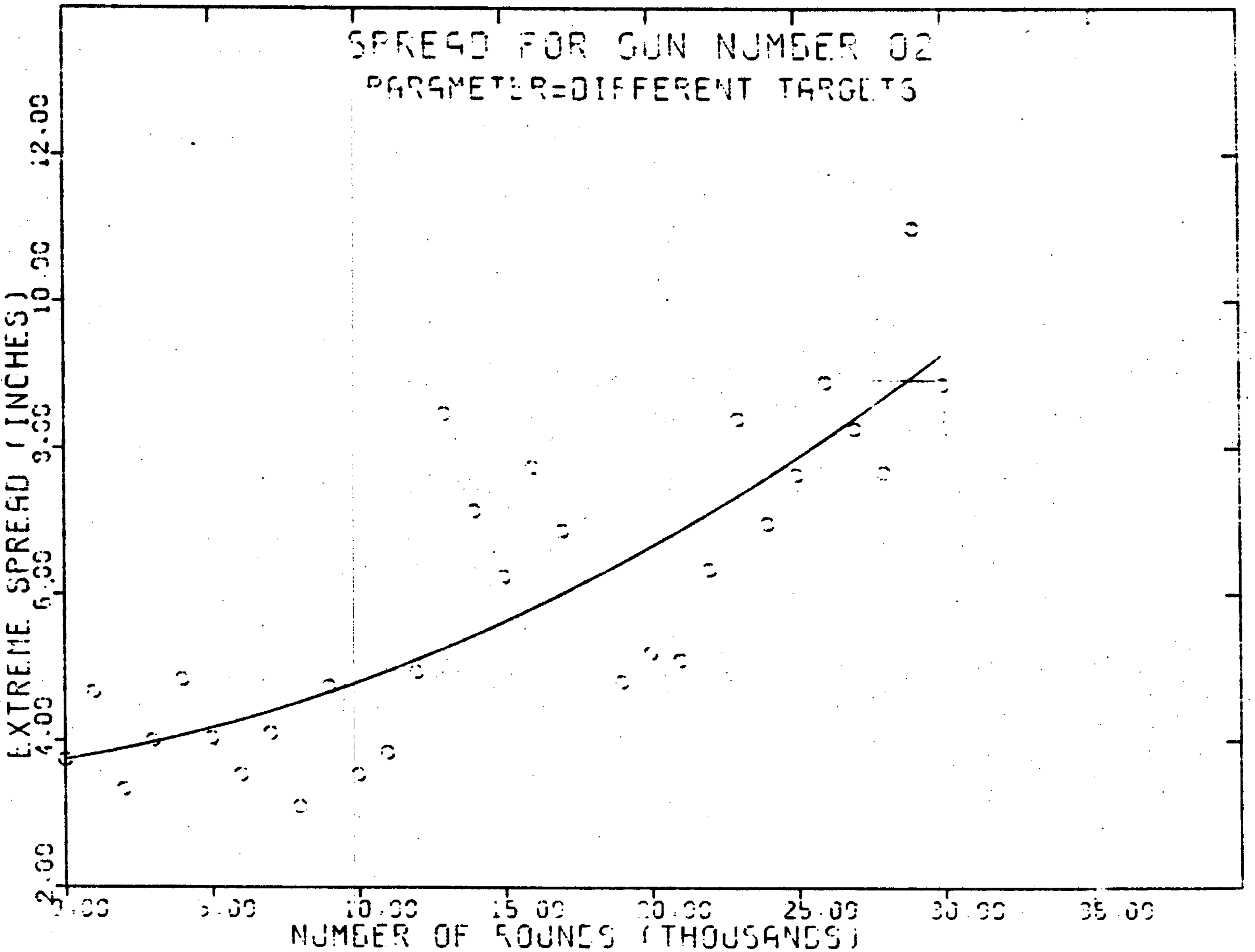


FIGURE 29 - Mean Extreme Spread for Gun Number 2

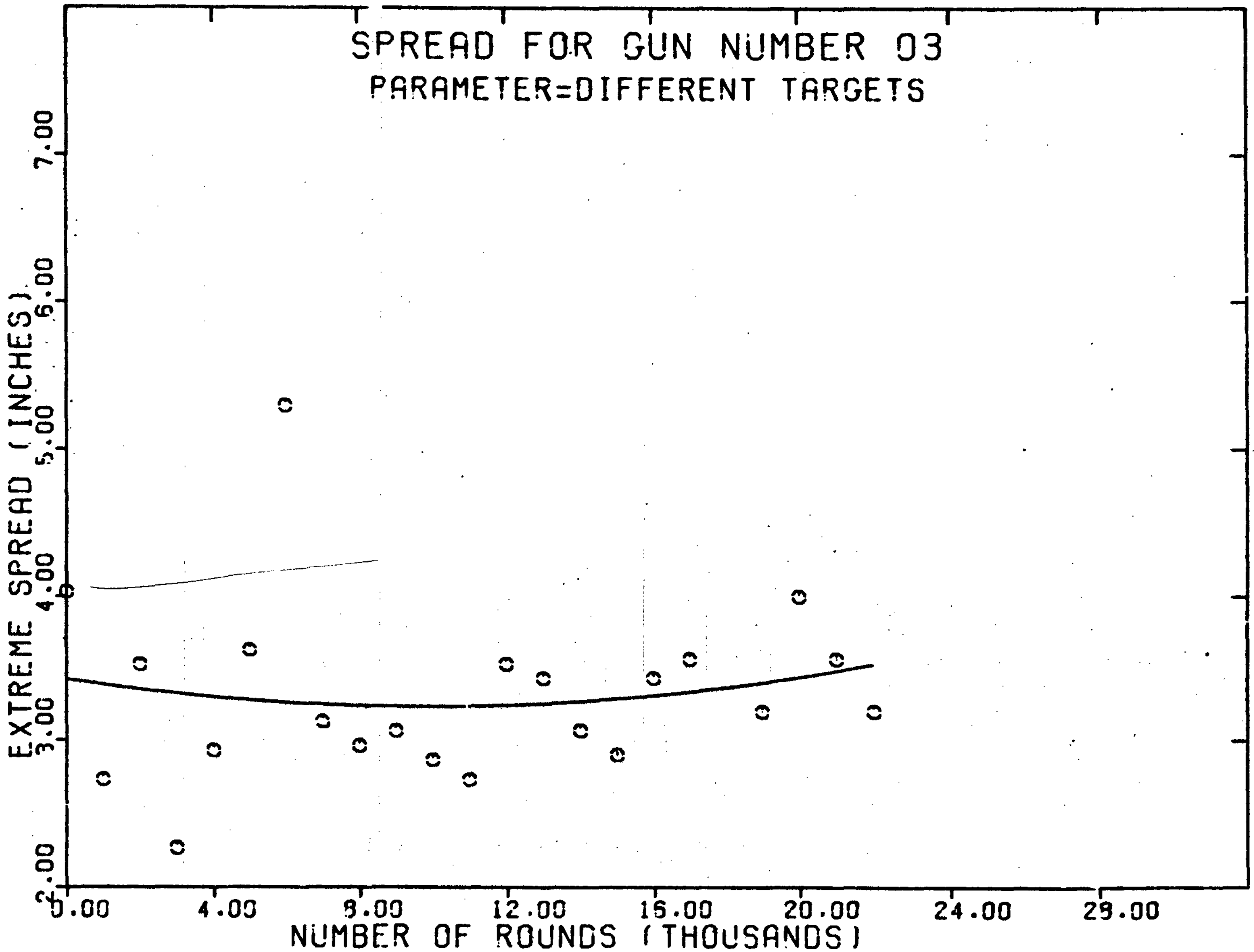


FIGURE 30 - Mean Extreme Spread for Gun Number 3

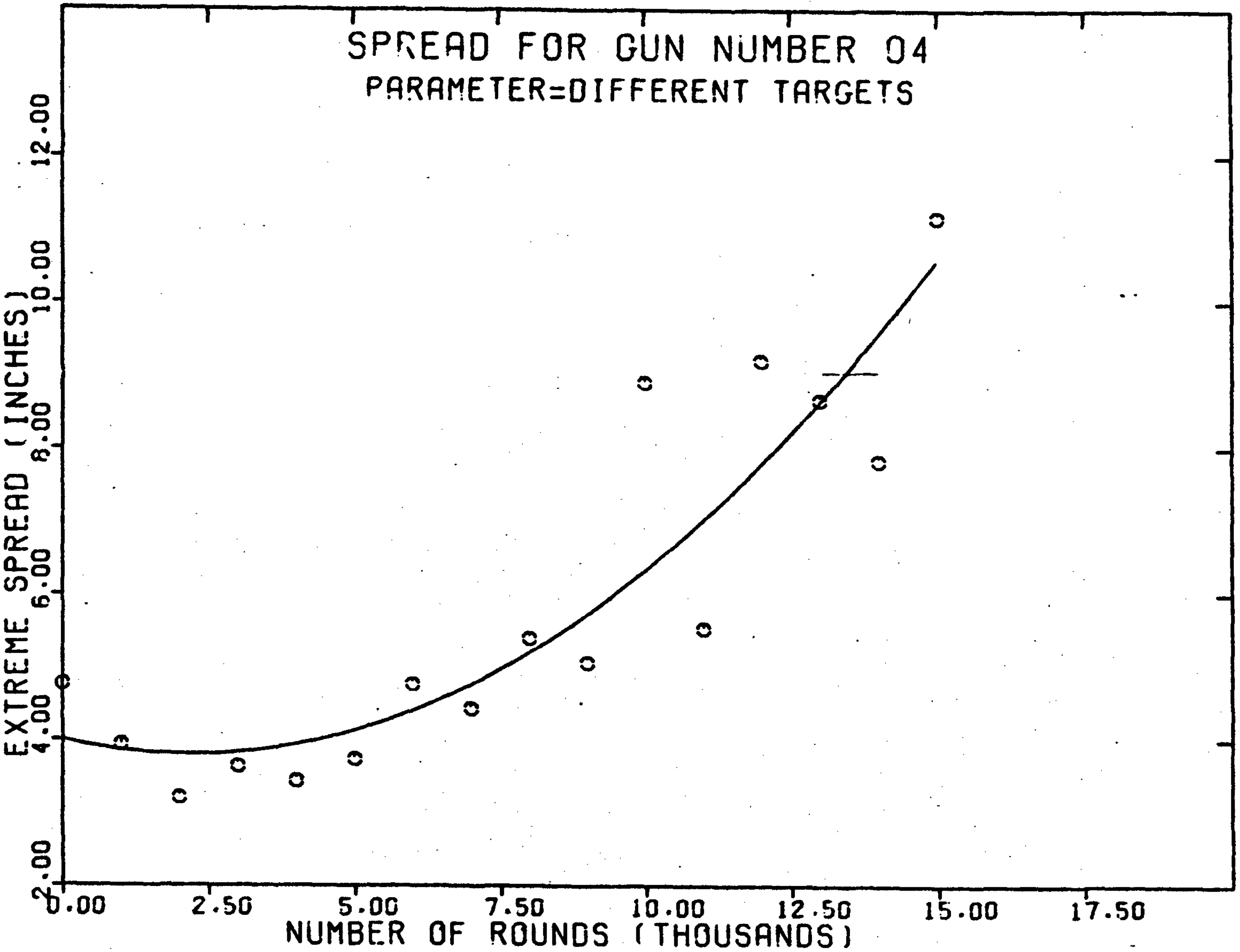


FIGURE 31 - Mean Extreme Spread for Gun Number 4

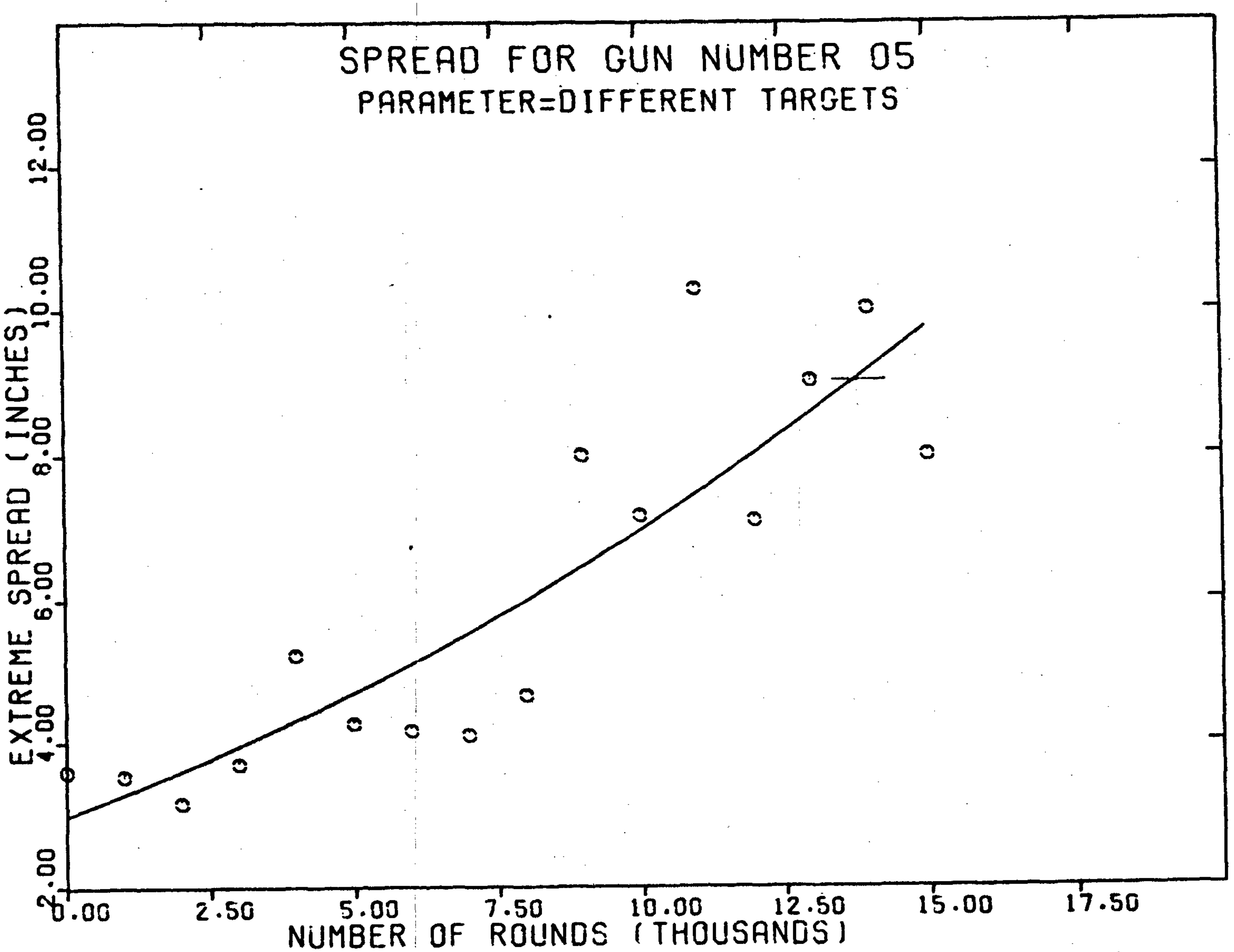


FIGURE 32 - Mean Extreme Spread for Gun Number 5

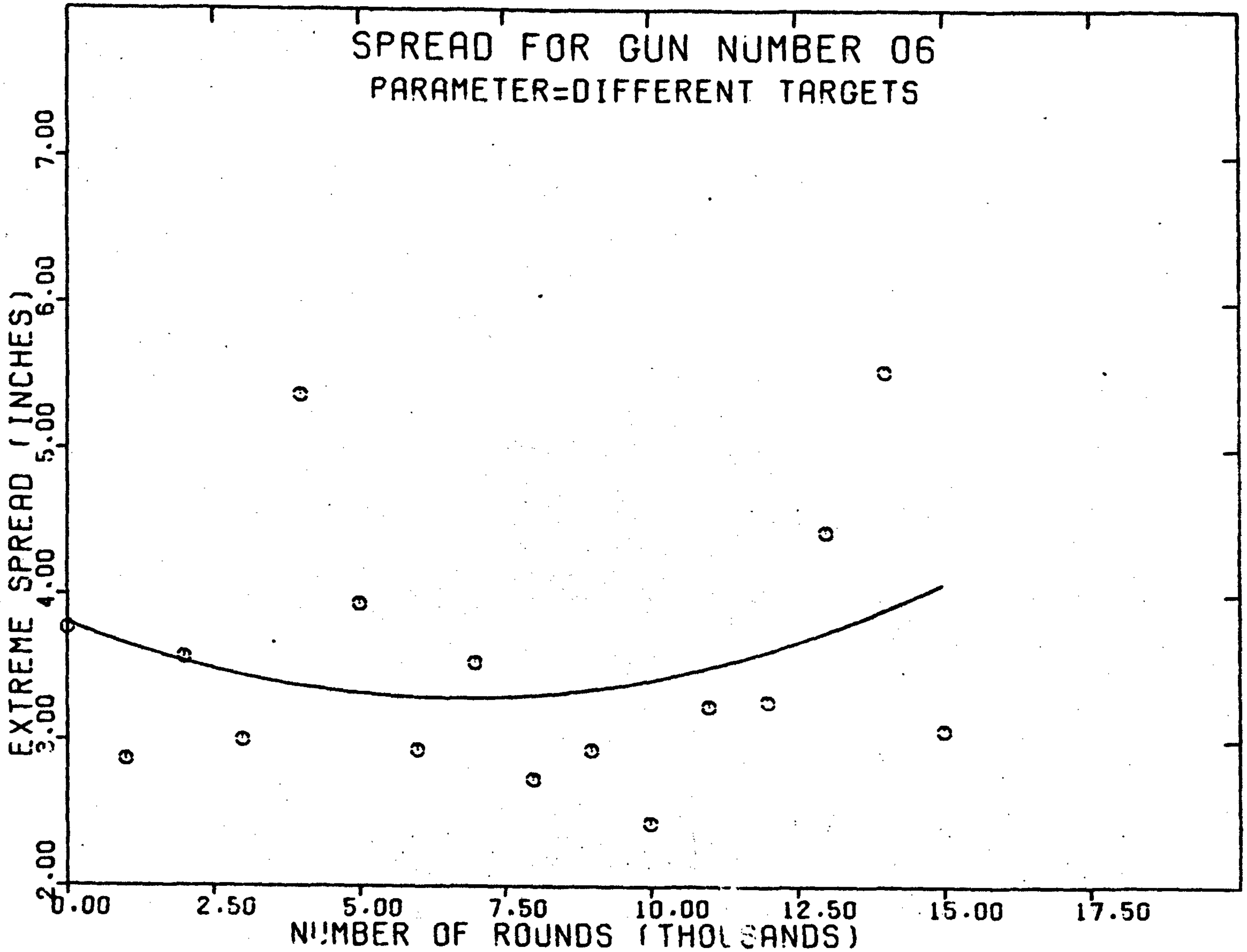


FIGURE 33 - Mean Extreme Spread for Gun Number 6

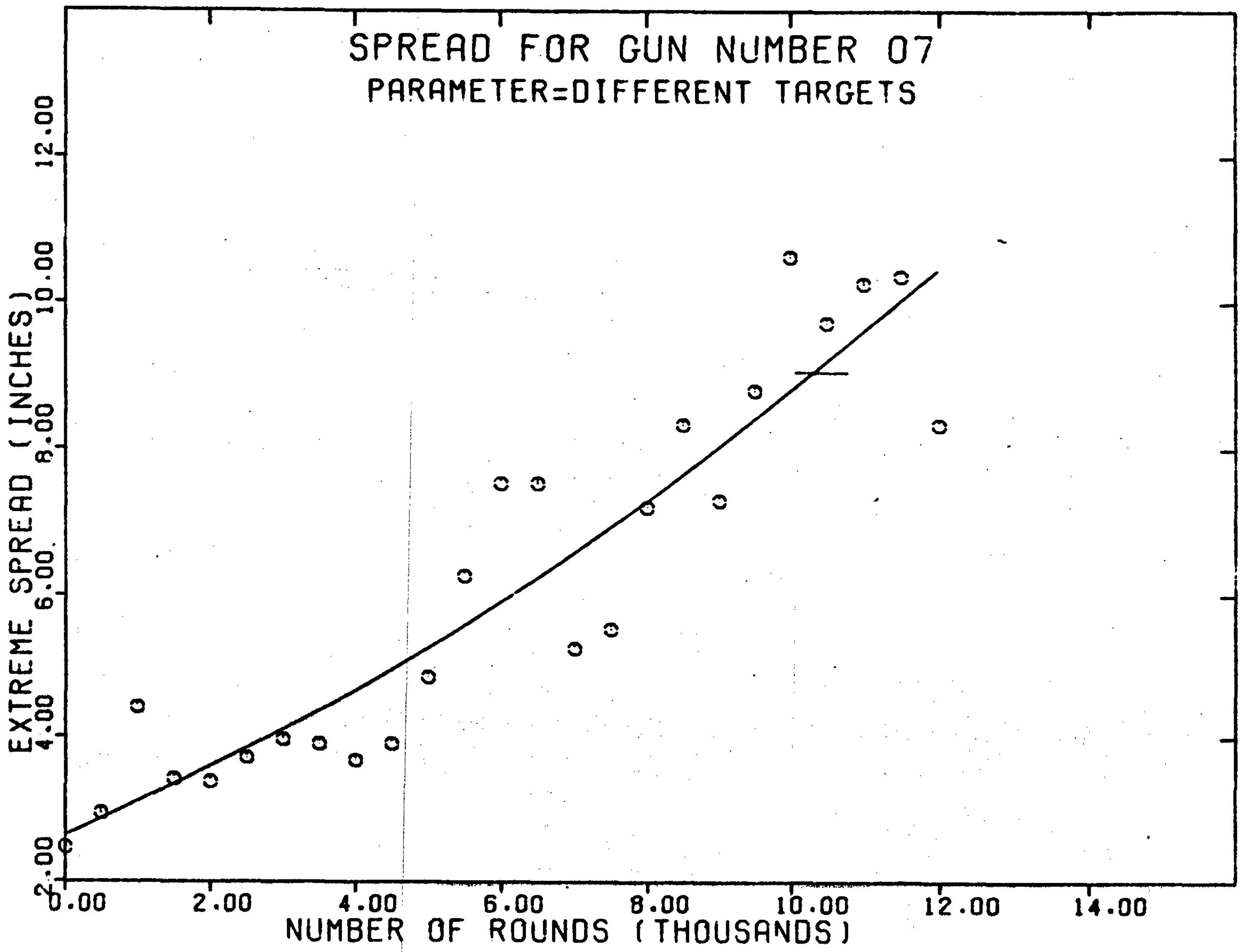


FIGURE 34 - Mean Extreme Spread for Gun Number 7

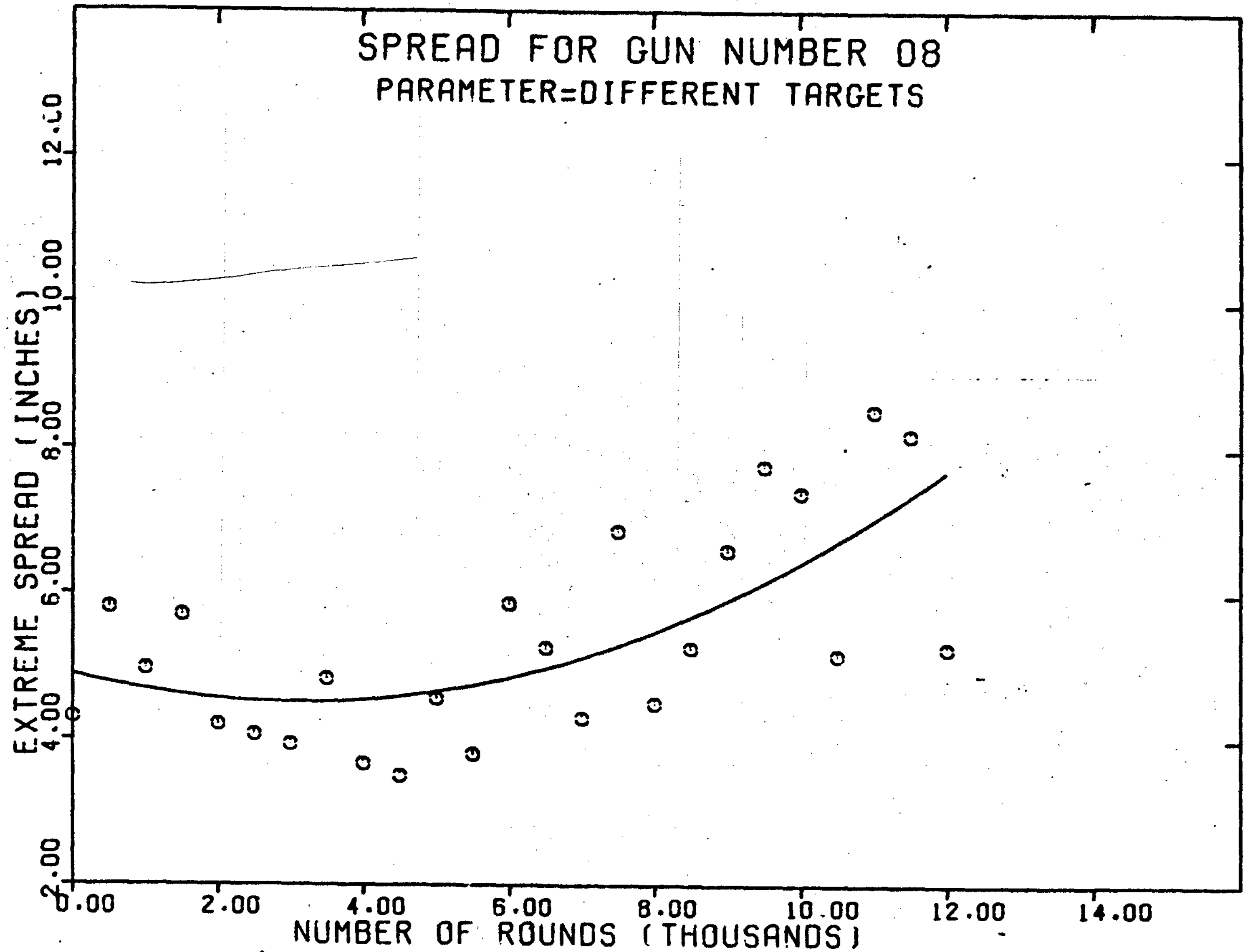


FIGURE 35 - Mean Extreme Spread for Gun Number 8

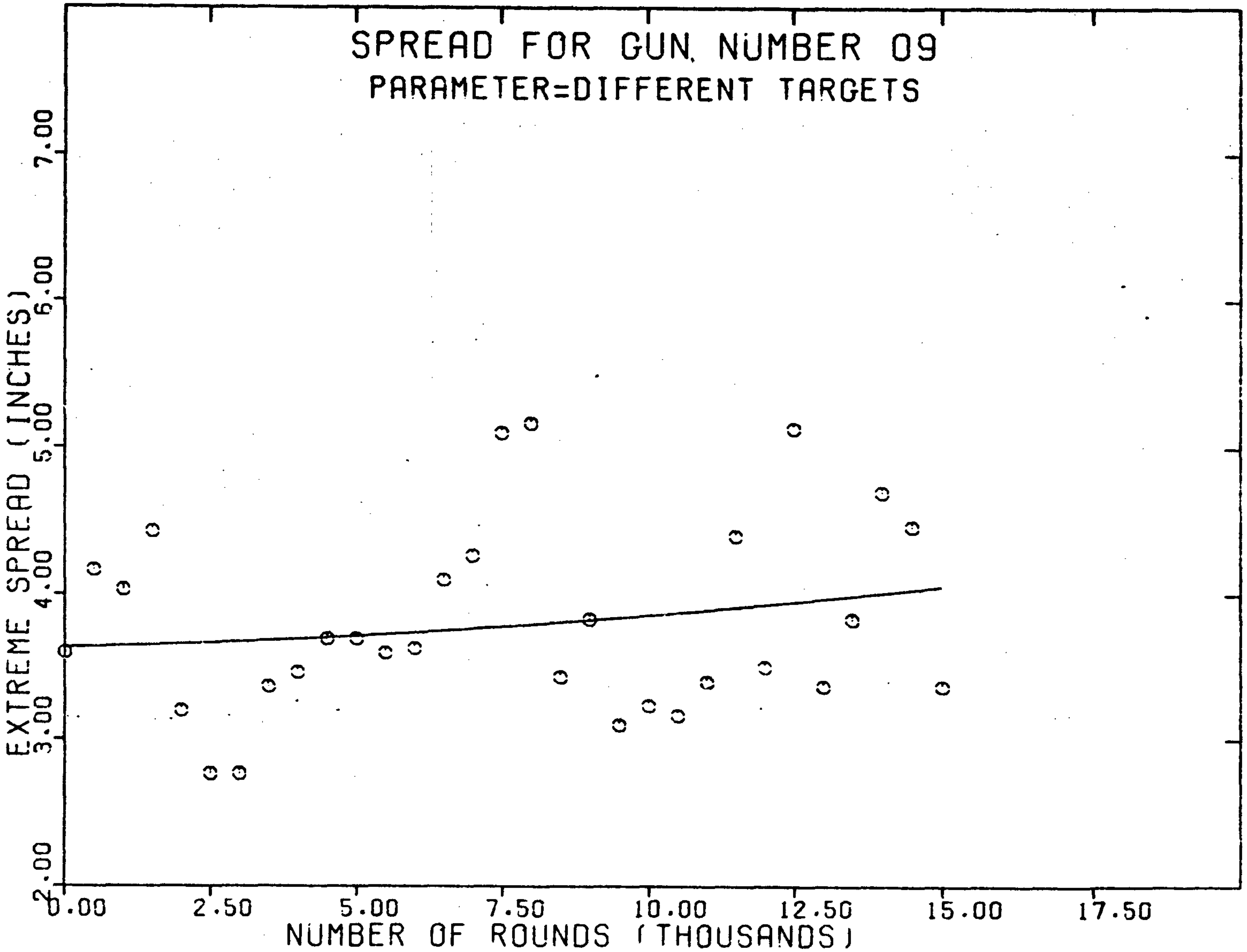


FIGURE 36 - Mean Extreme Spread for Gun Number 9

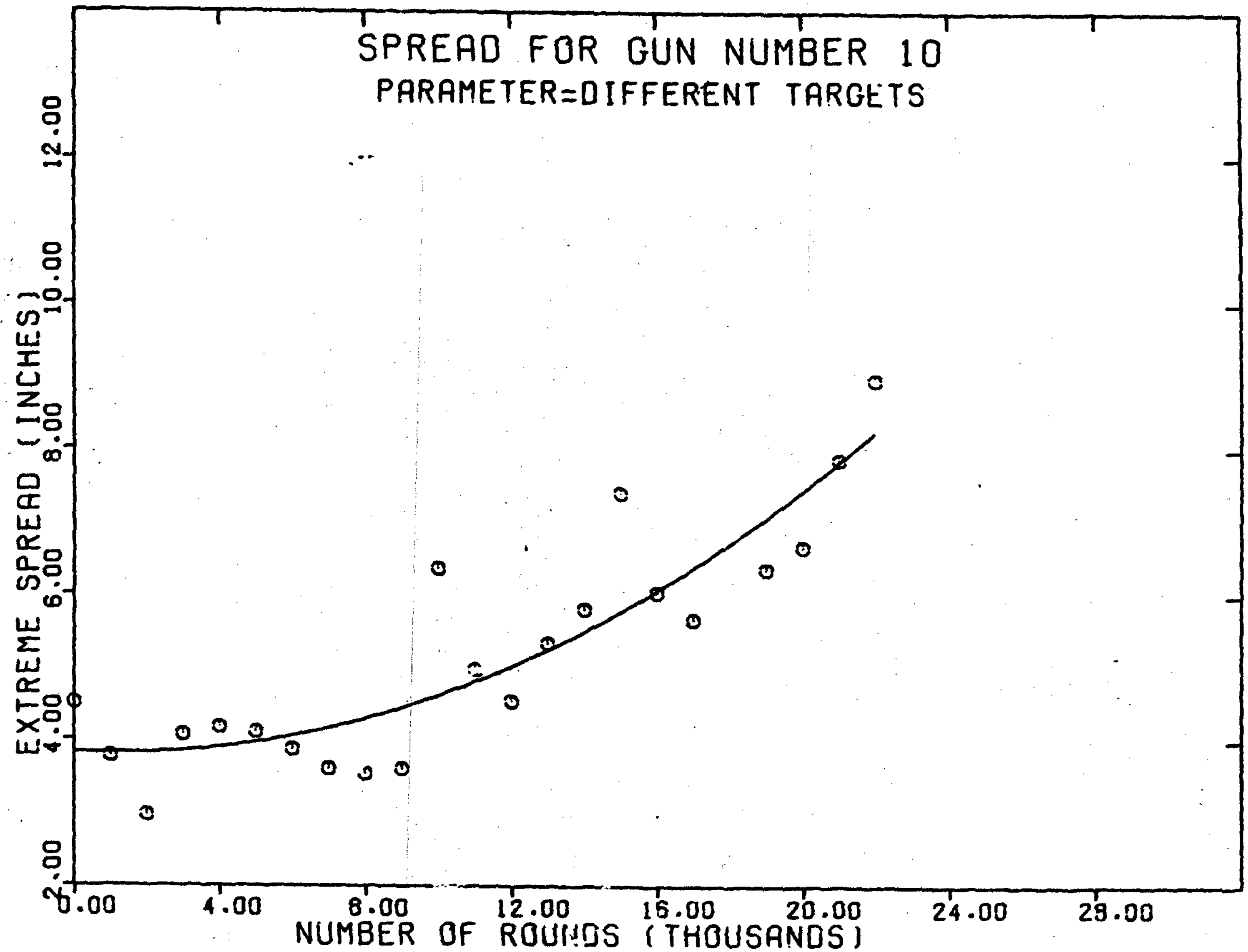


FIGURE 37 - Mean Extreme Spread for Gun Number 10

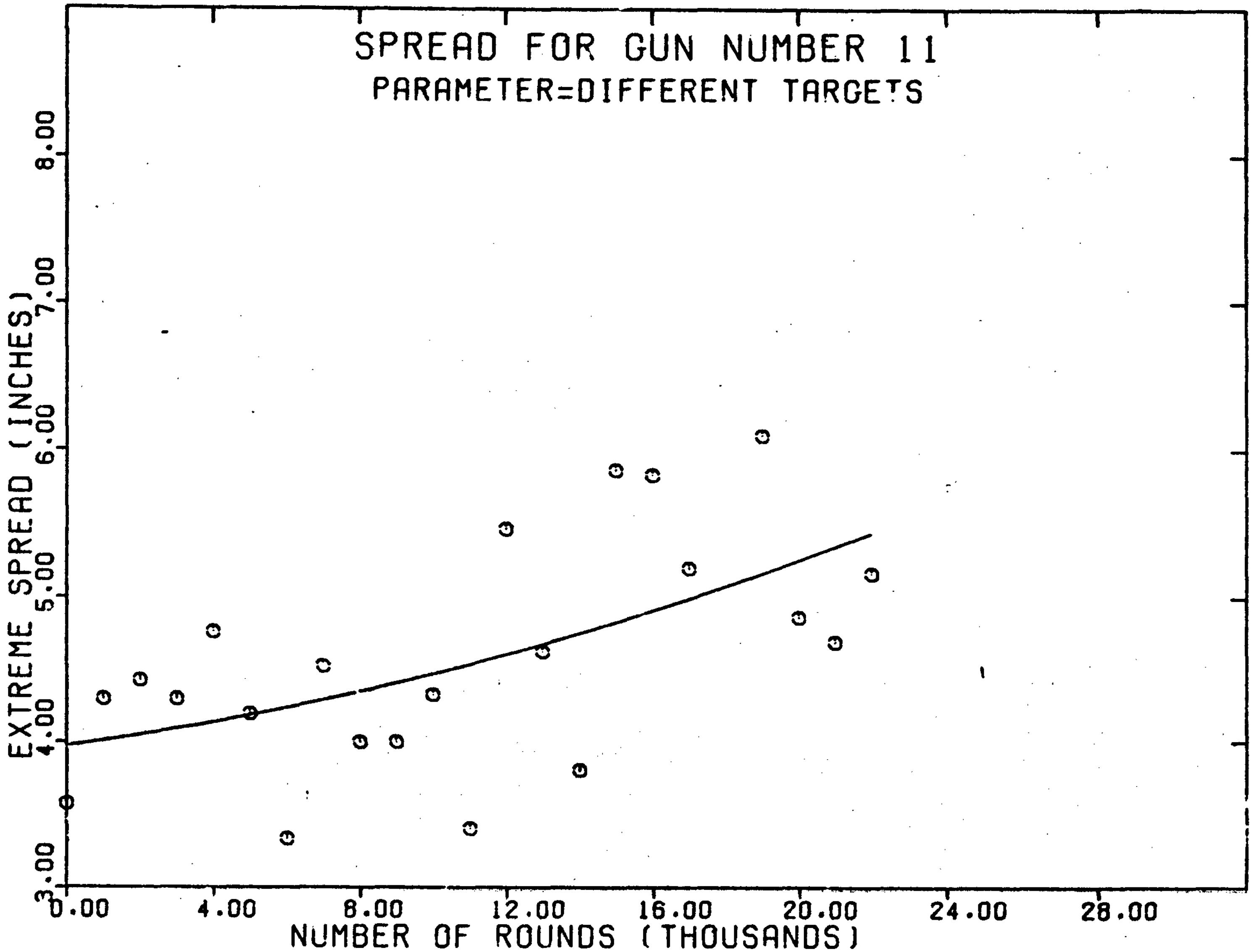


FIGURE 38 - Mean Extreme Spread for Gun Number 11

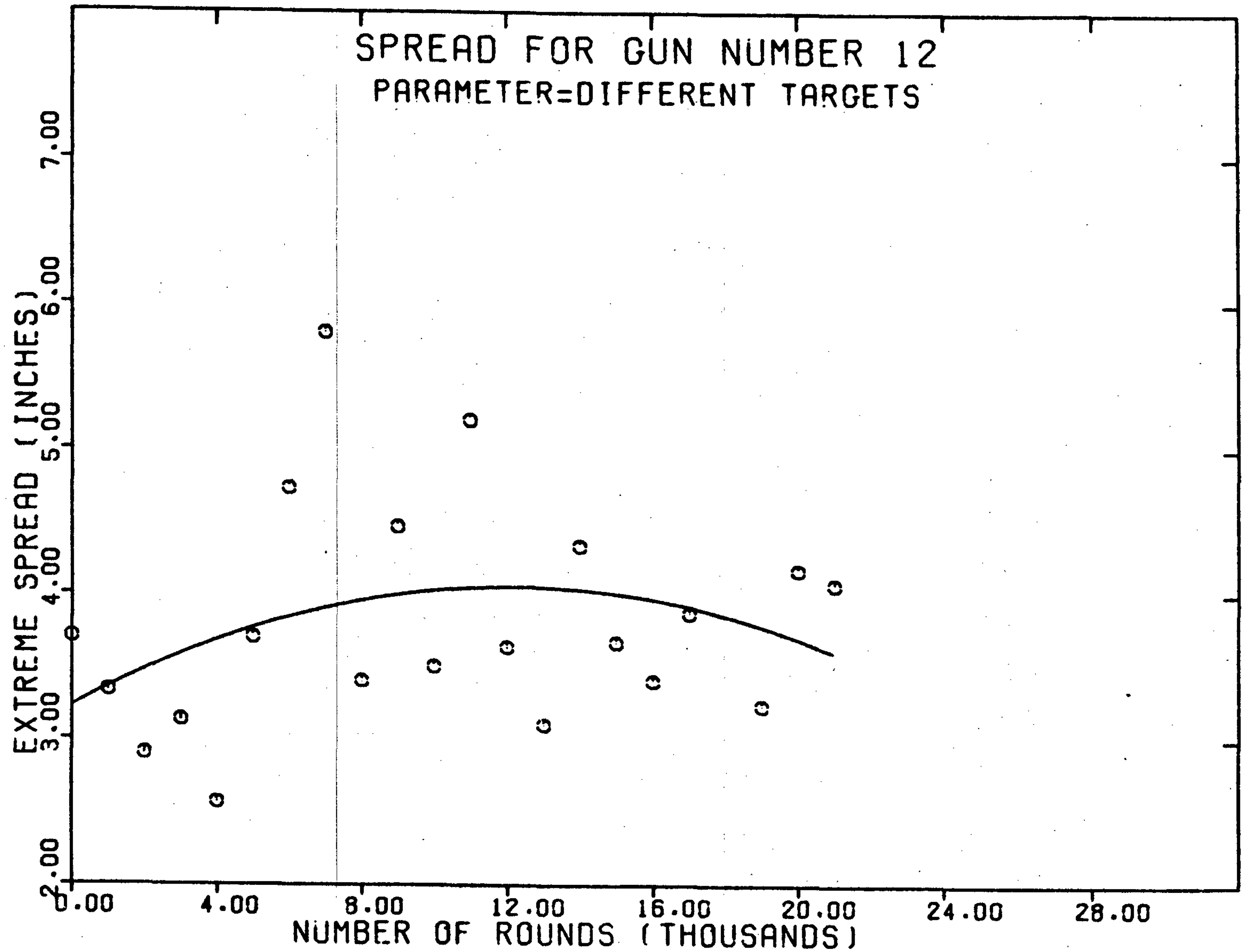


FIGURE 39 - Mean Extreme Spread for Gun Number 12

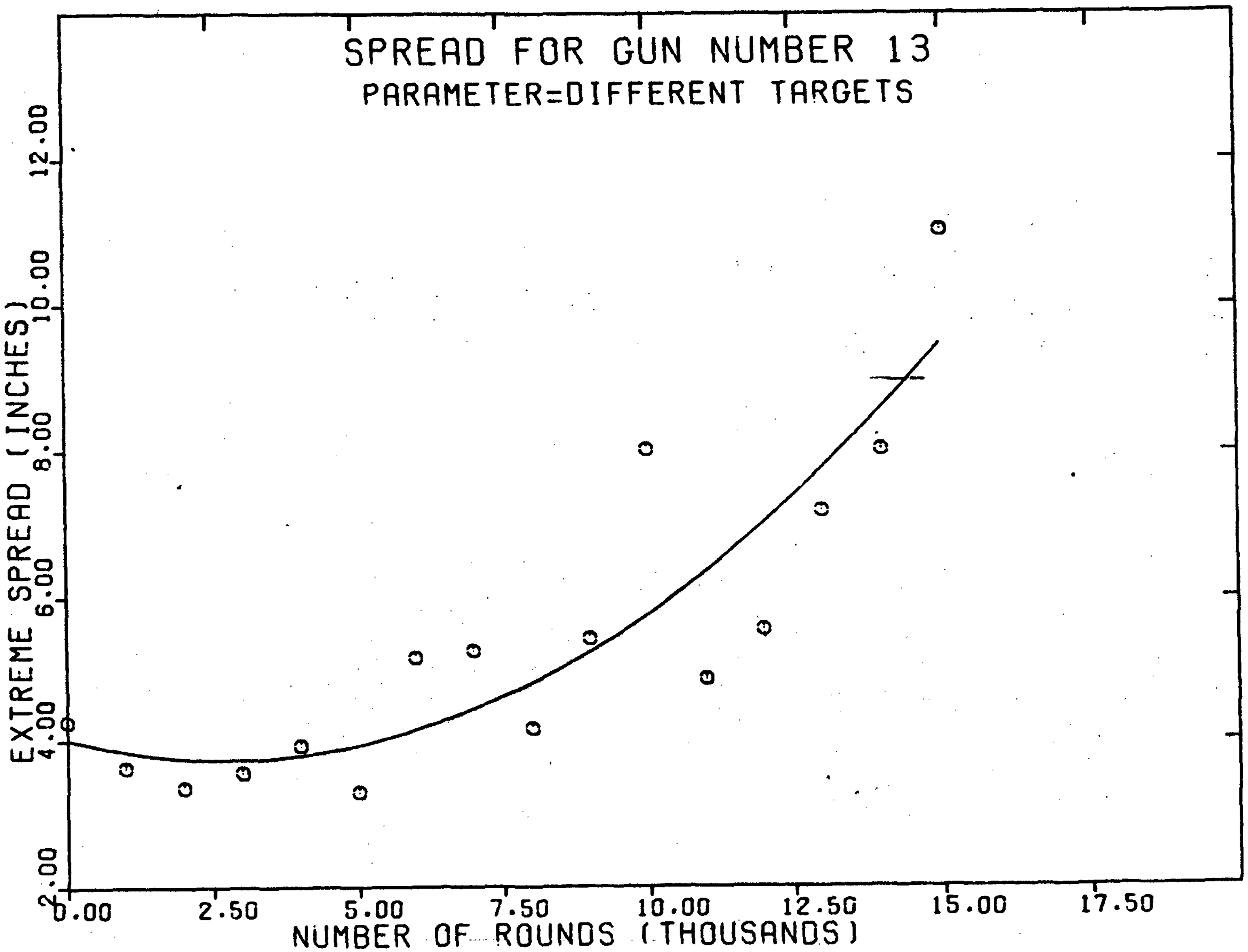


FIGURE 40 - Mean Extreme Spread for Gun Number 13

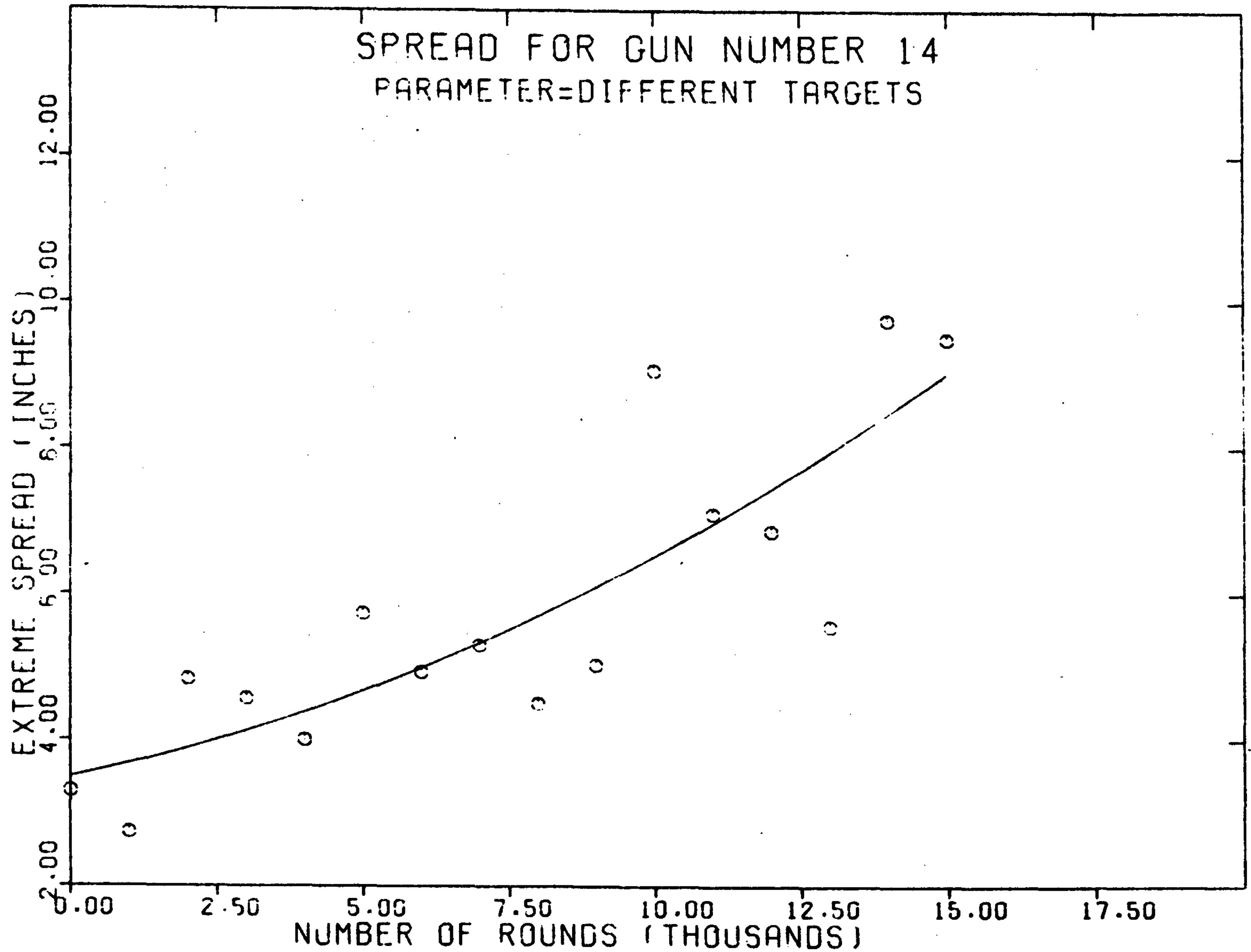


FIGURE 41 - Mean Extreme Spread for Gun Number 14

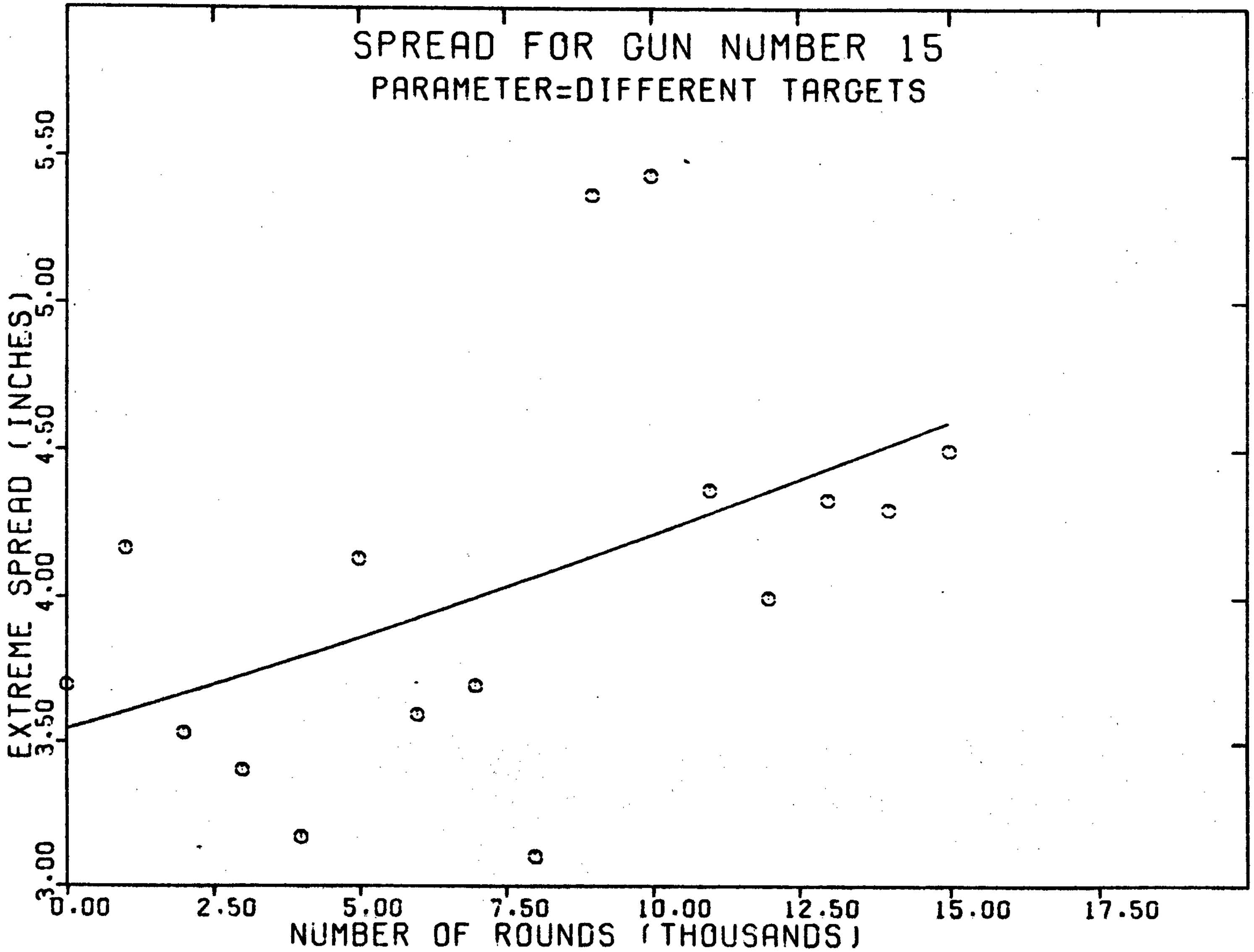


FIGURE 42 - Mean Extreme Spread for Gun Number 15

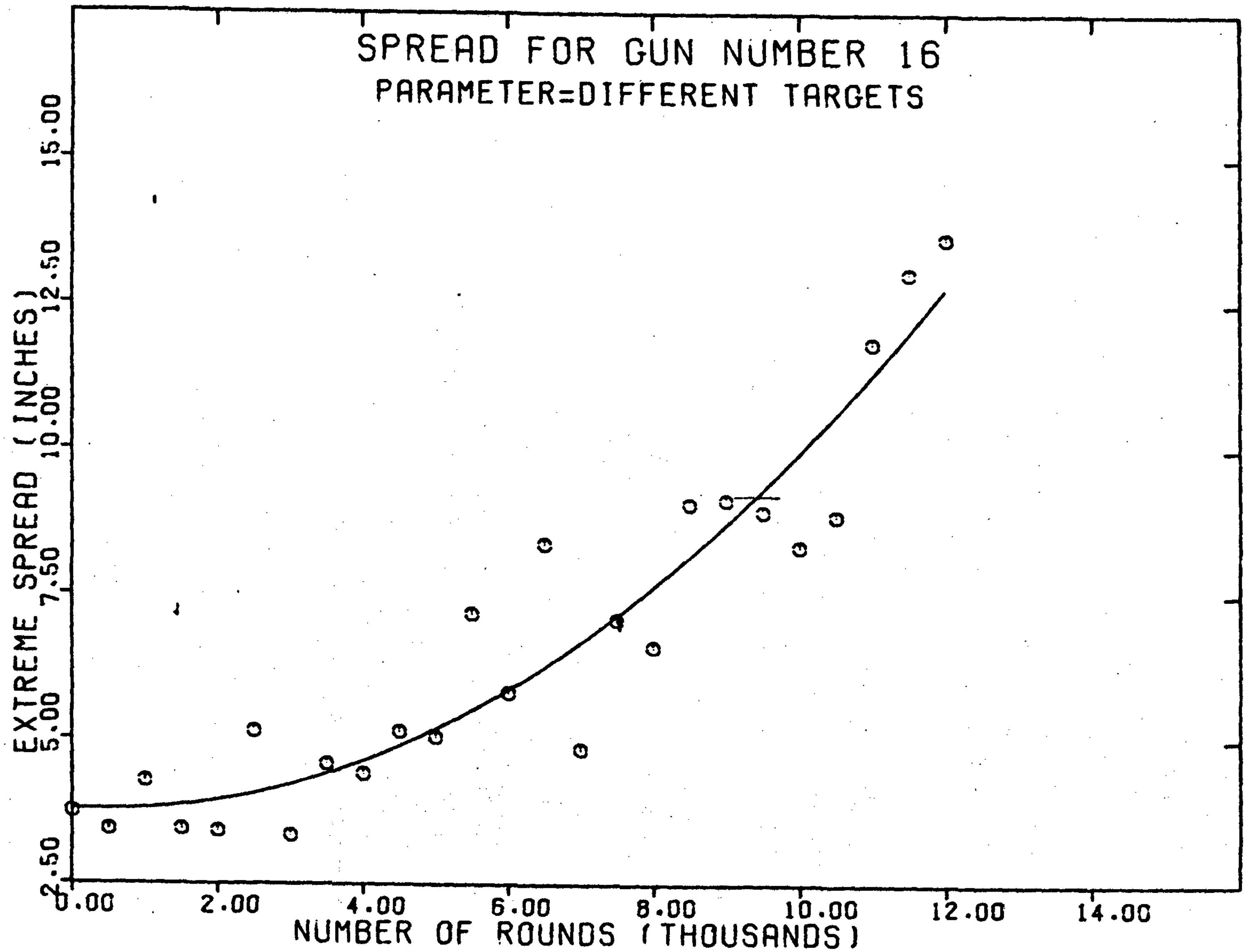


FIGURE 43 - Mean Extreme Spread for Gun Number 16

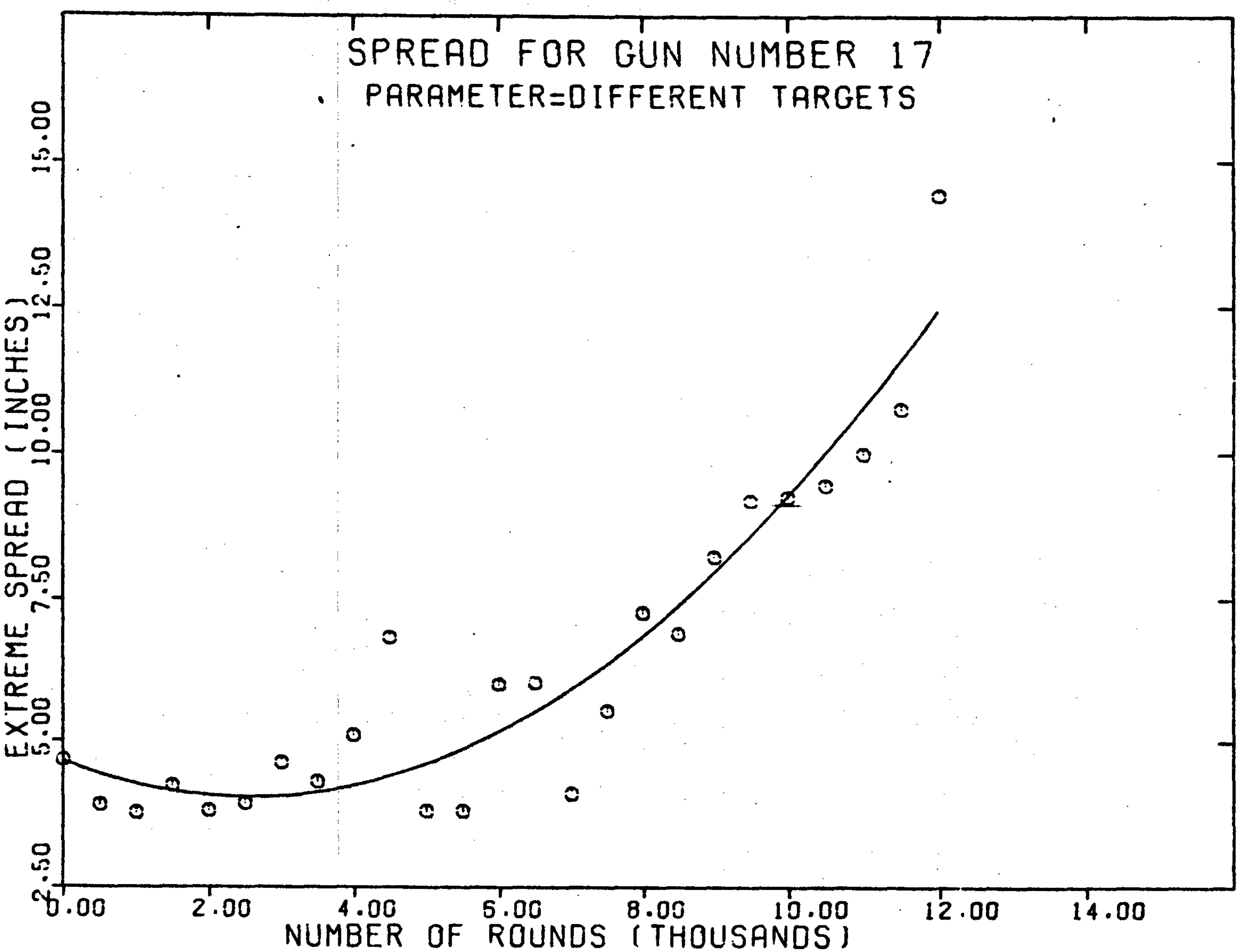


FIGURE 44 - Mean Extreme Spread for Gun Number 17

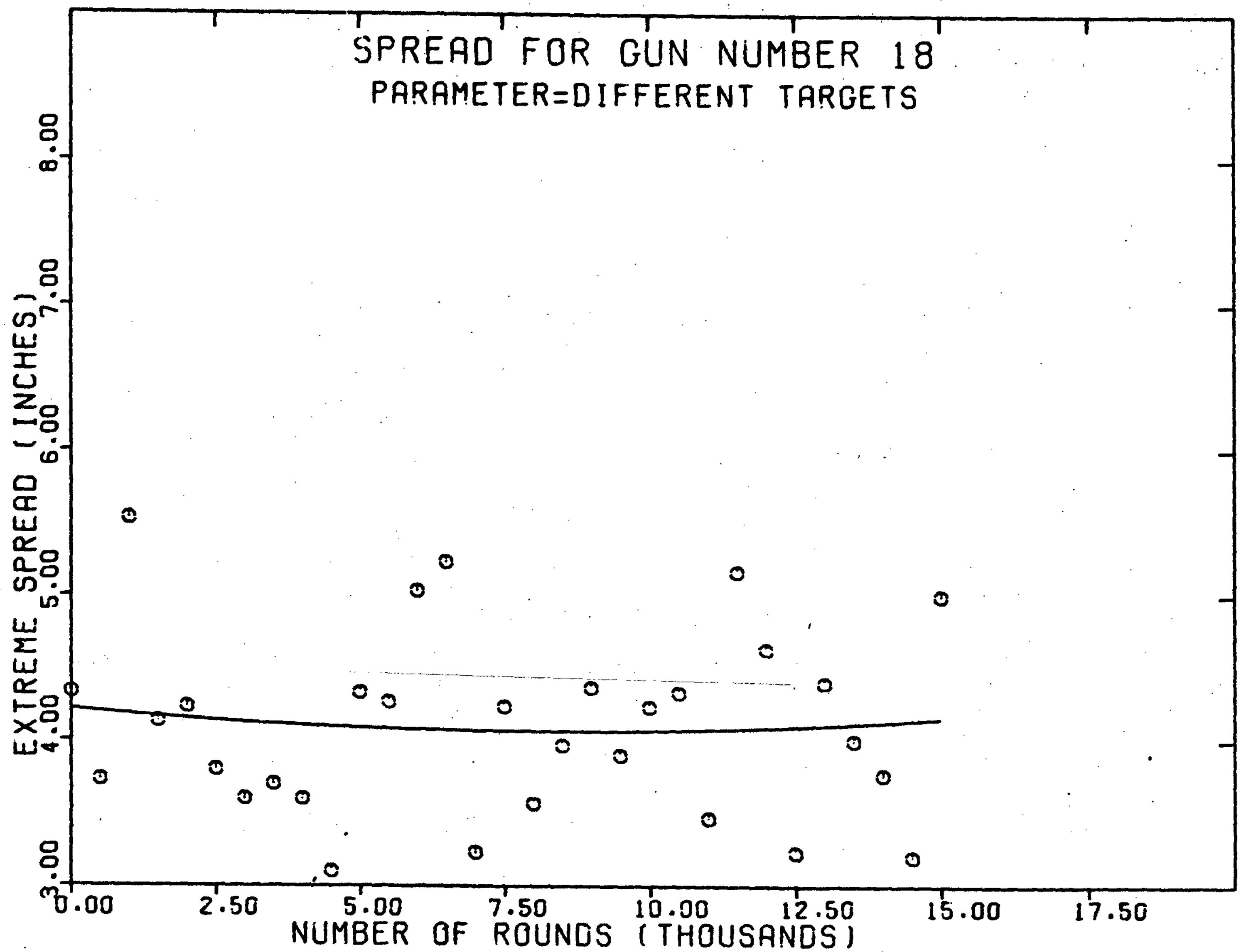


FIGURE 45- Mean Extreme Spread for Gun Number 18

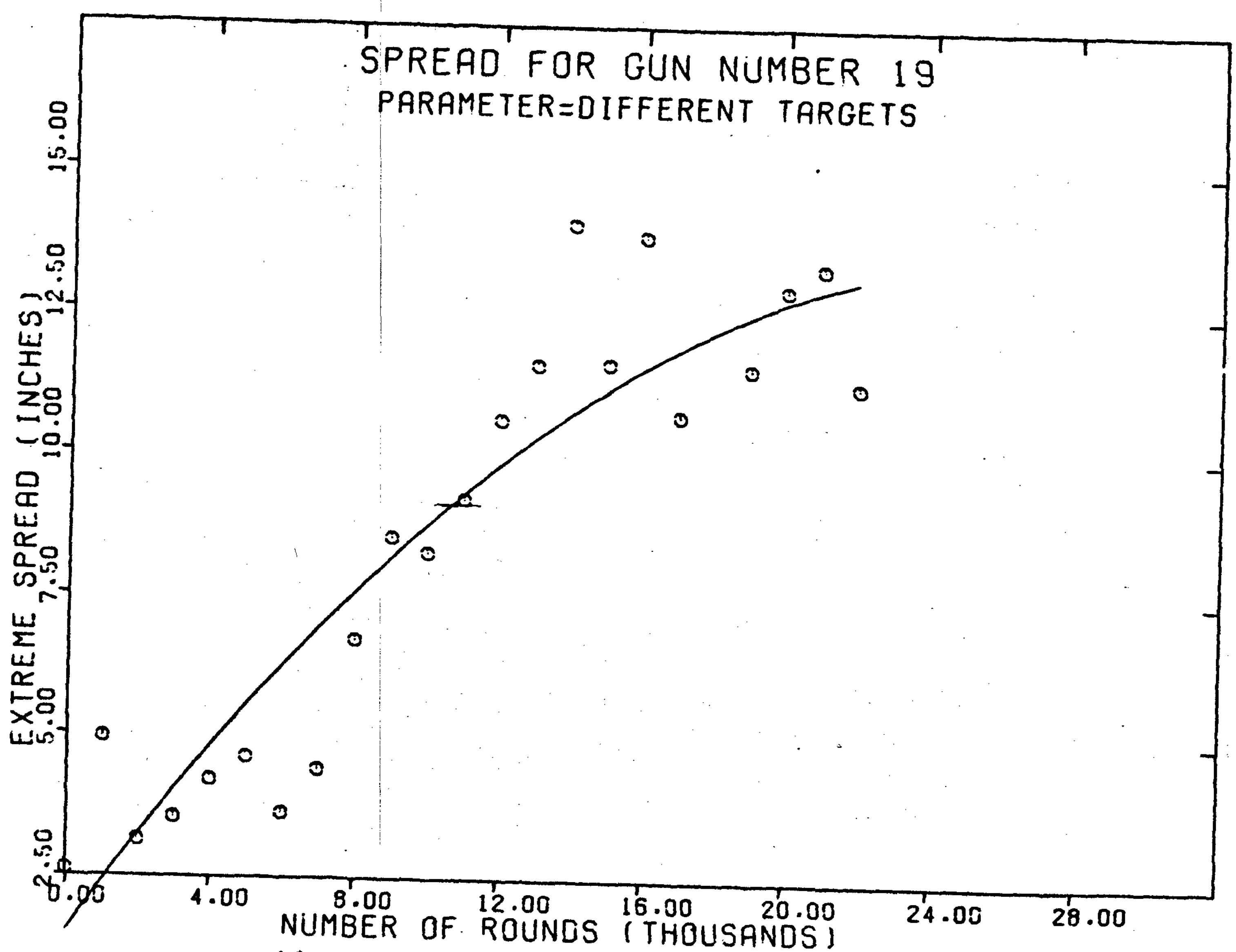


FIGURE 46 - Mean Extreme Spread for Gun Number 19

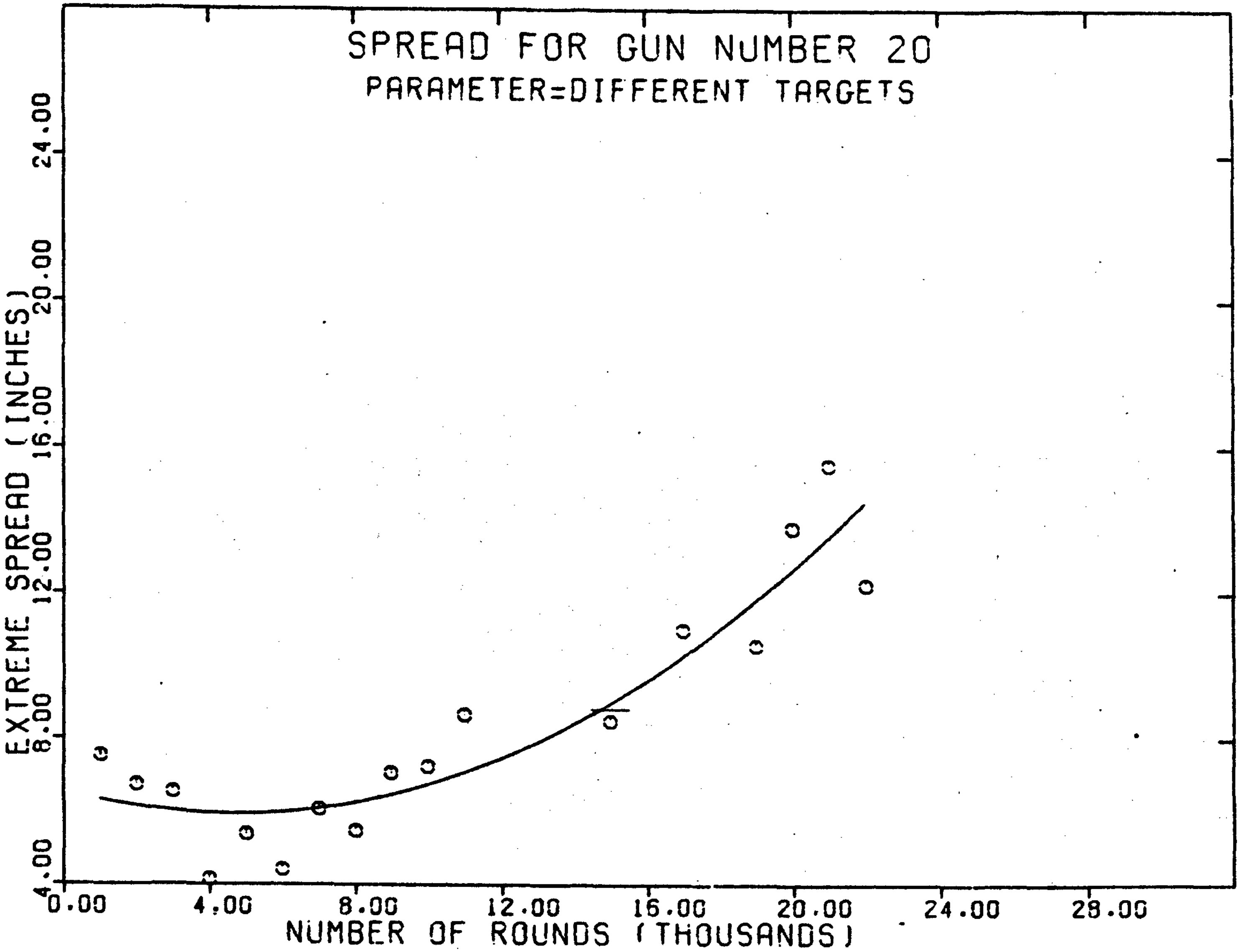


FIGURE 47 - Mean Extreme Spread for Gun Number 20

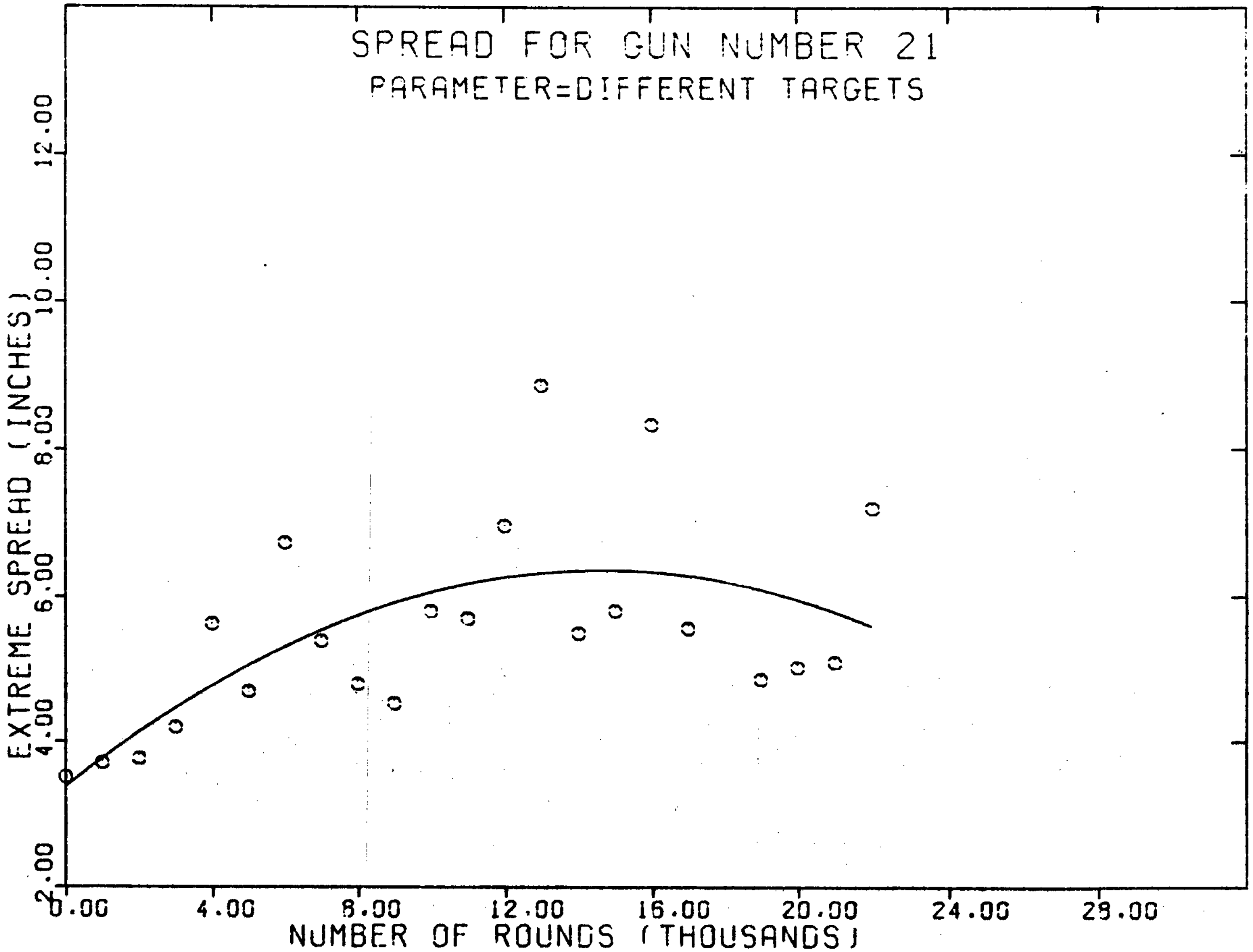


FIGURE 48 - Mean Extreme Spread for Gun Number 21

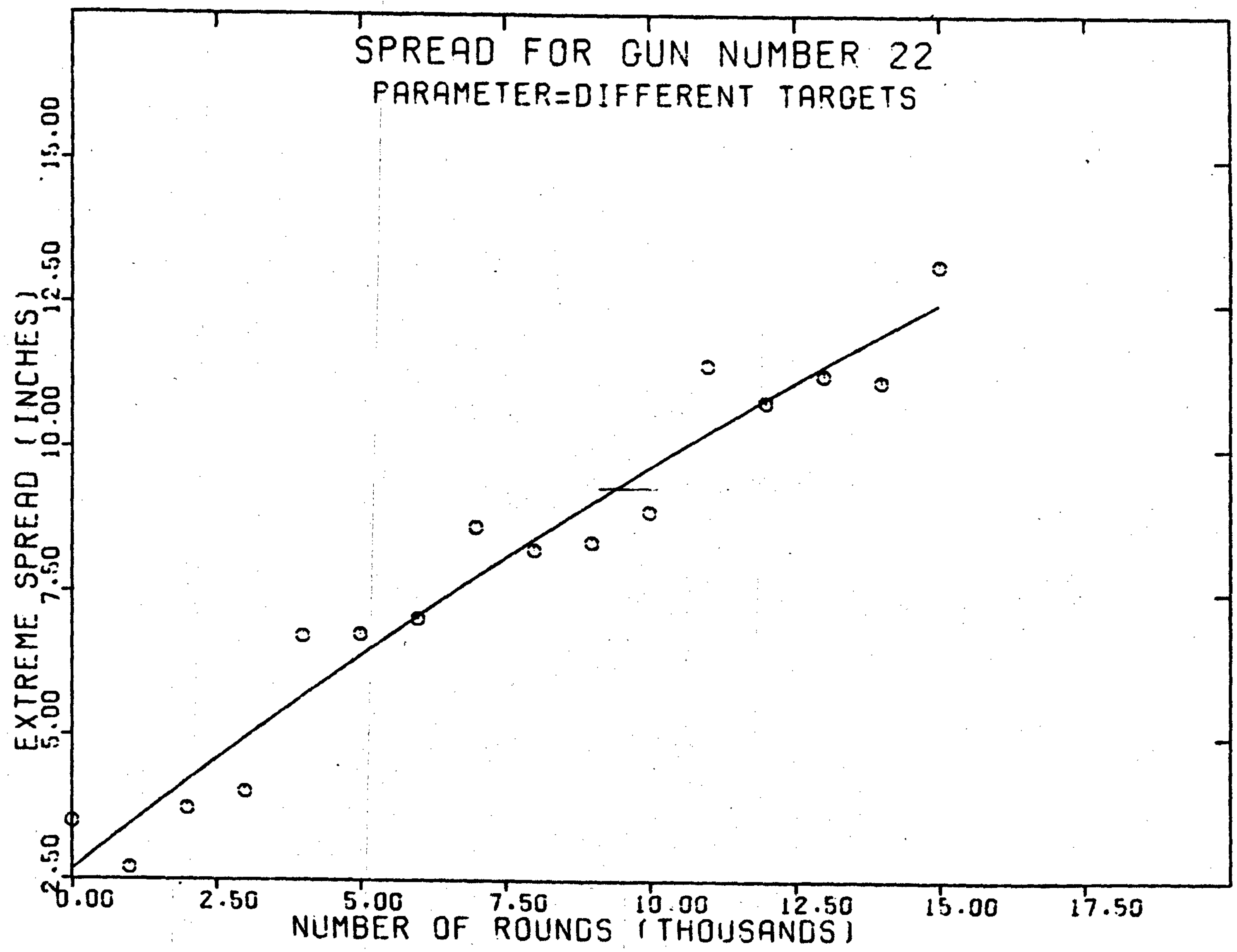


FIGURE 49 - Mean Extreme Spread for Gun Number 22

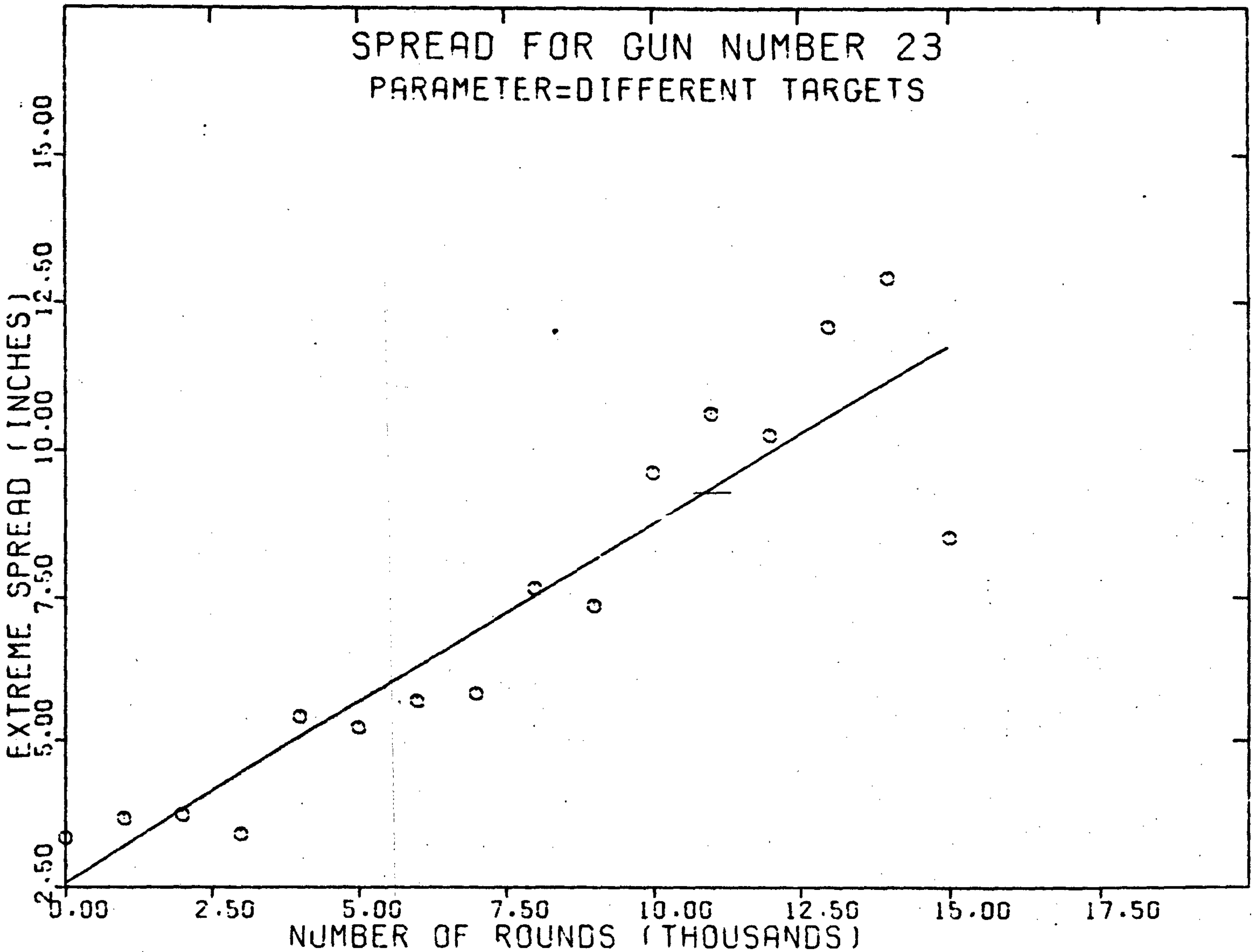


FIGURE 50 - Mean Extreme Spread for Gun Number 23

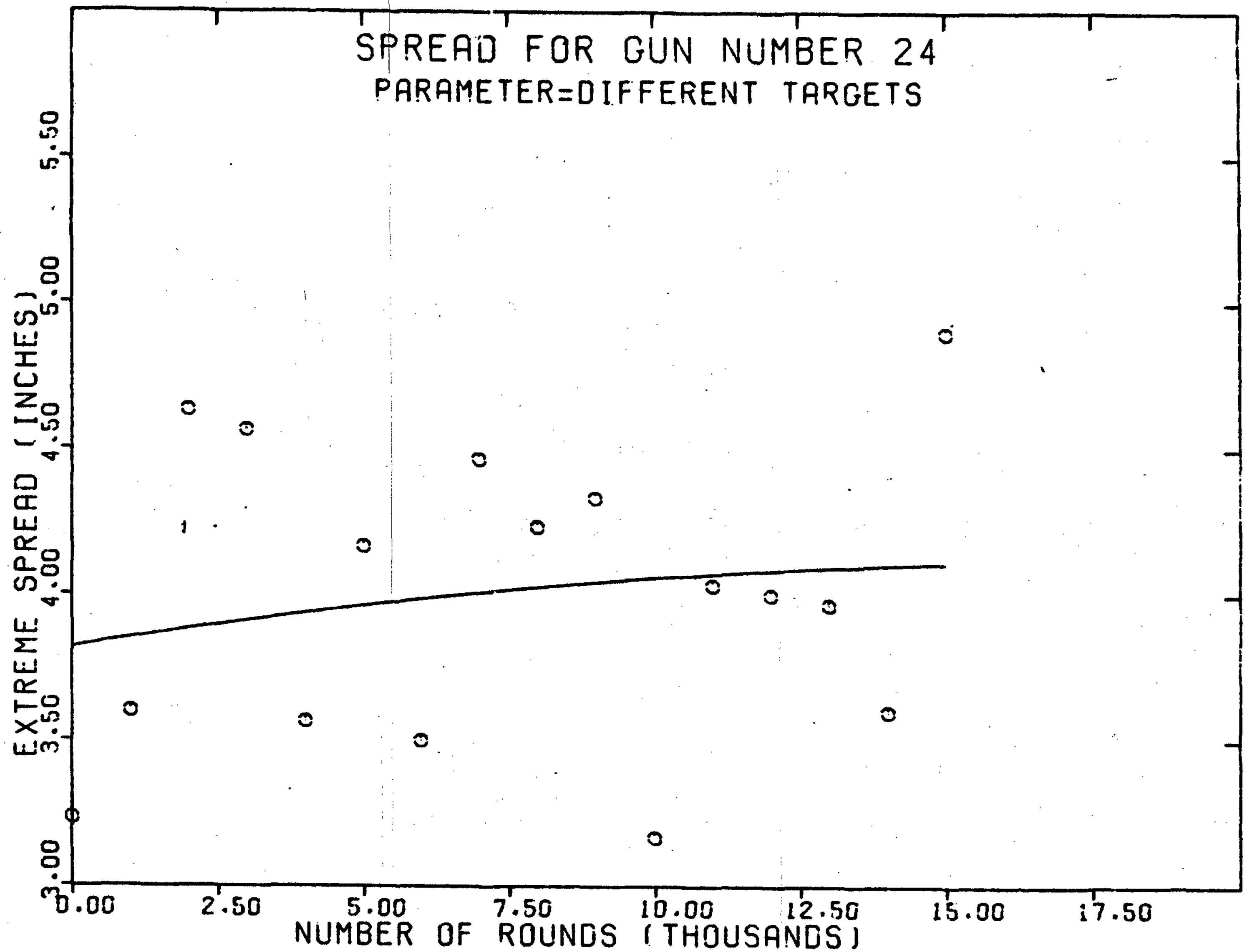


FIGURE 51 - Mean Extreme Spread for Gun Number 24

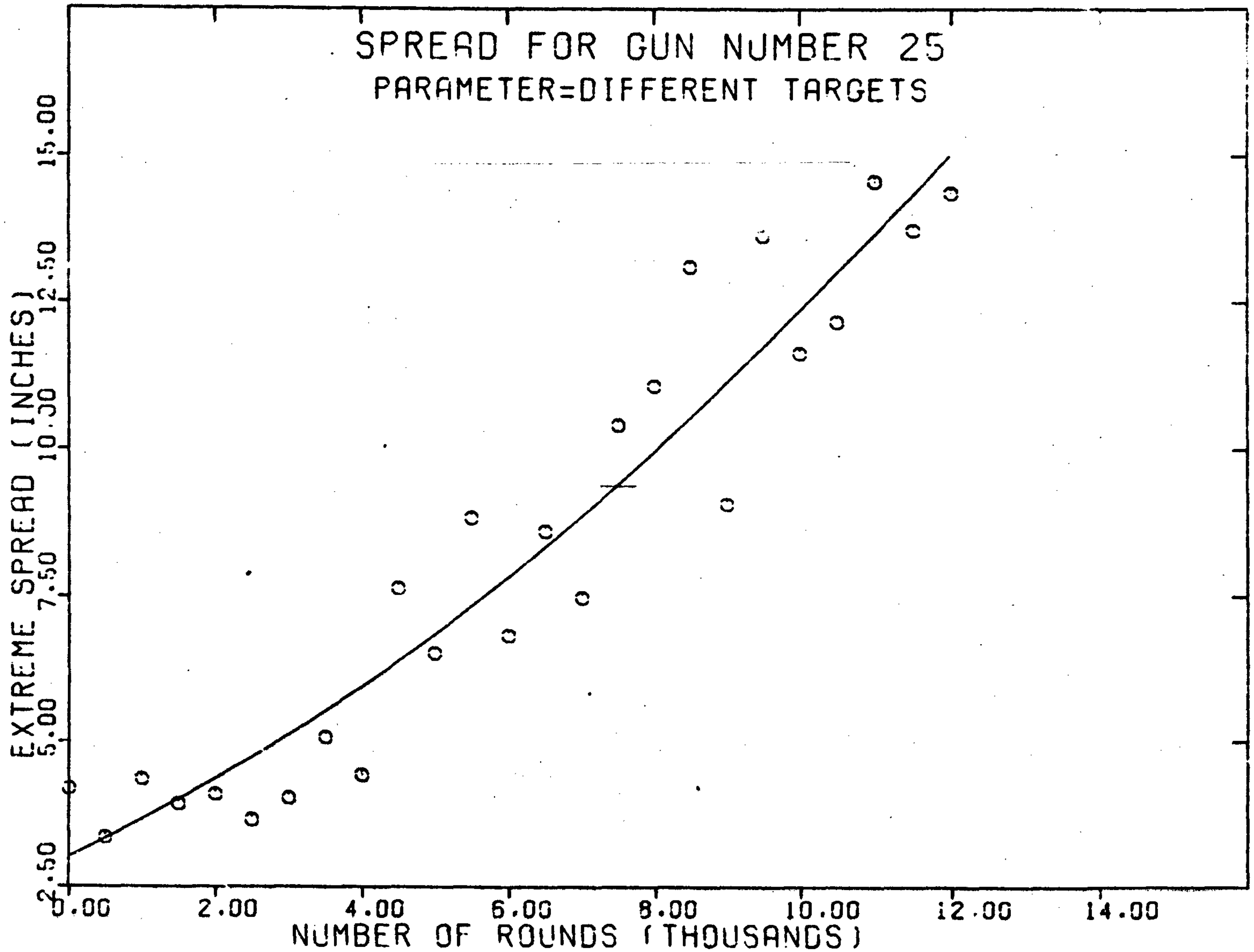


FIGURE 52 - Mean Extréme Spread for Gun Number 25

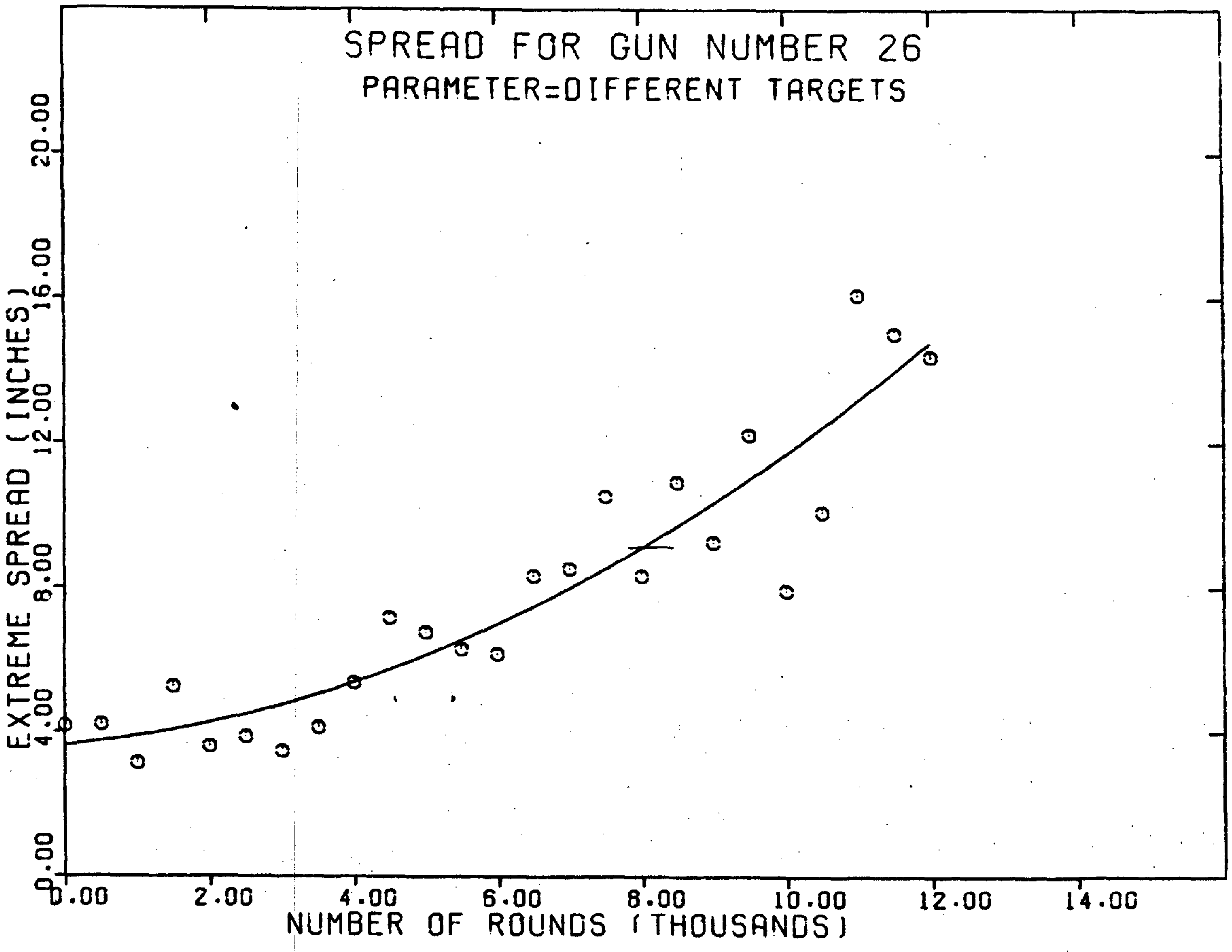


FIGURE 53 - Mean Extreme Spread for Gun Number 26

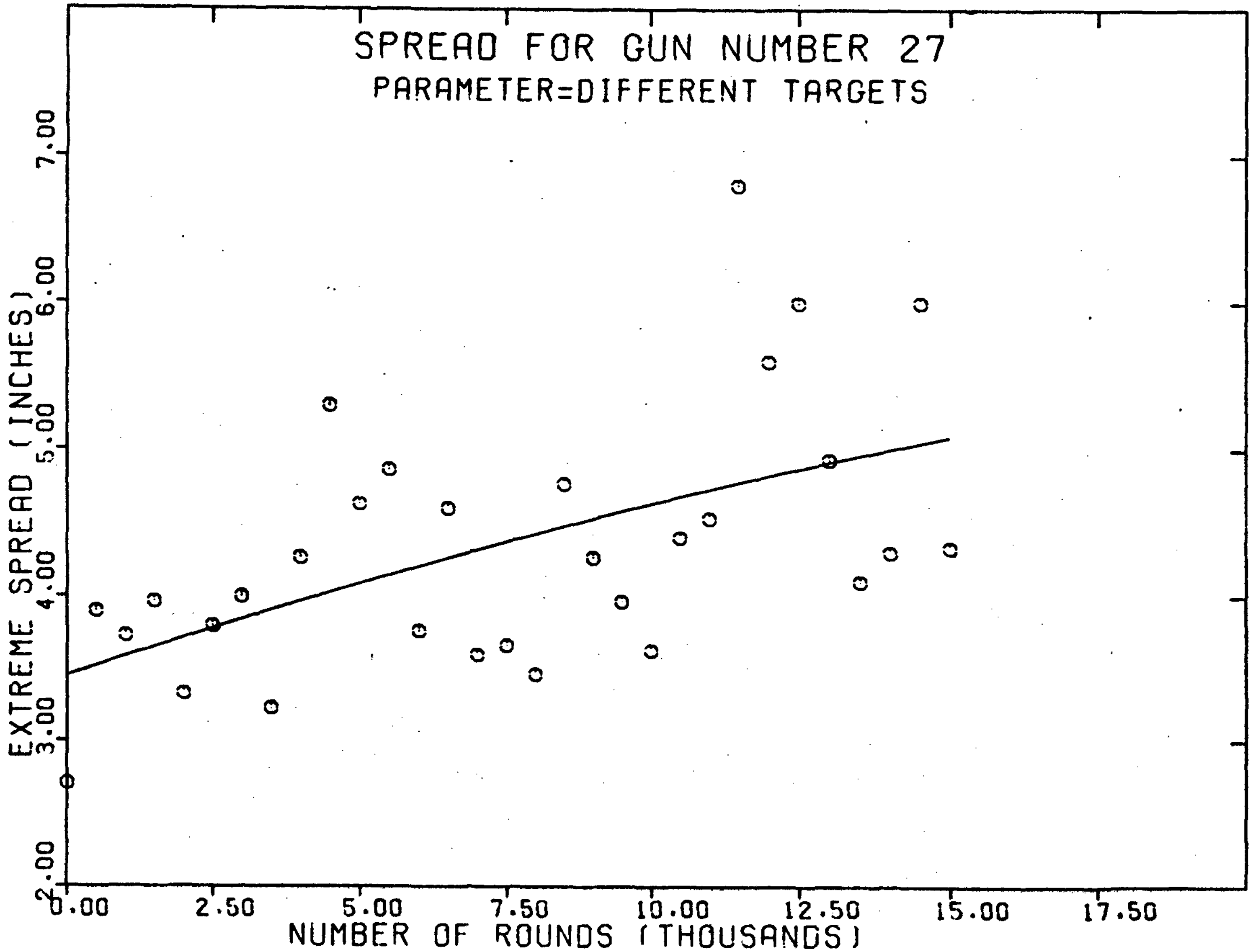


FIGURE 54 - Mean Extreme Spread for Gun Number 27

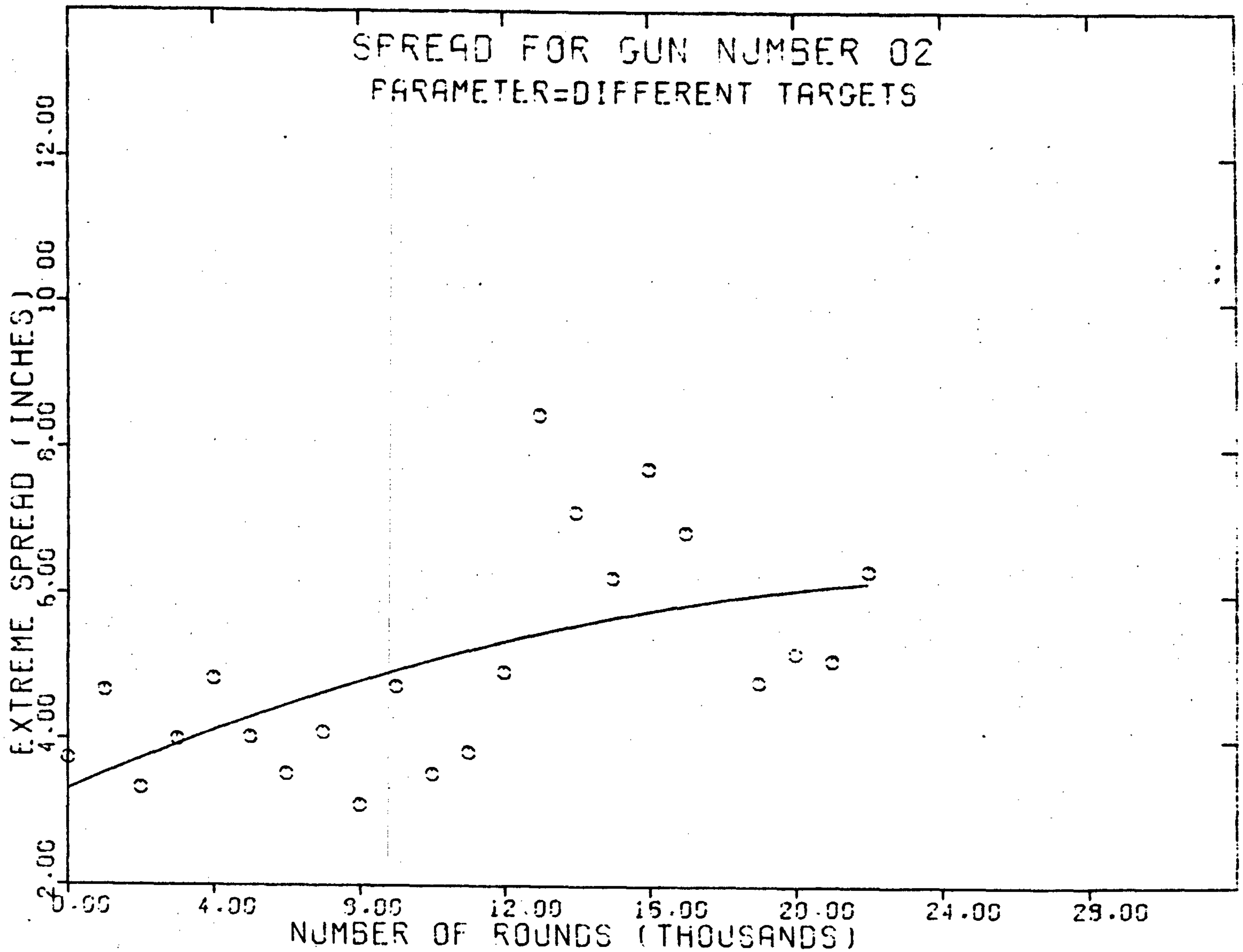


FIGURE 55 - Mean Extreme Spread for Gun Number 2

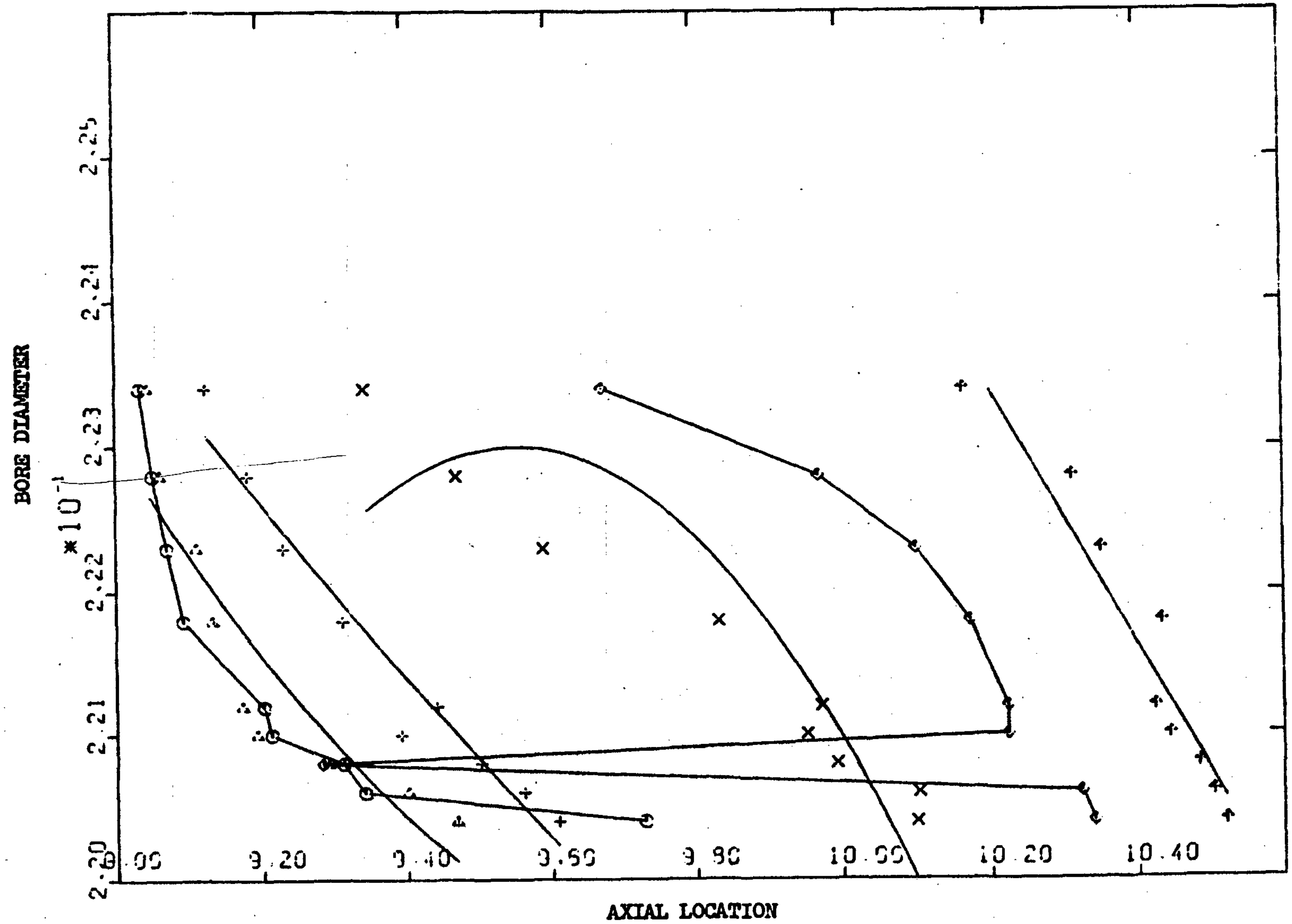


FIGURE 56 - Variation of Bore Shape for Gun Number 1

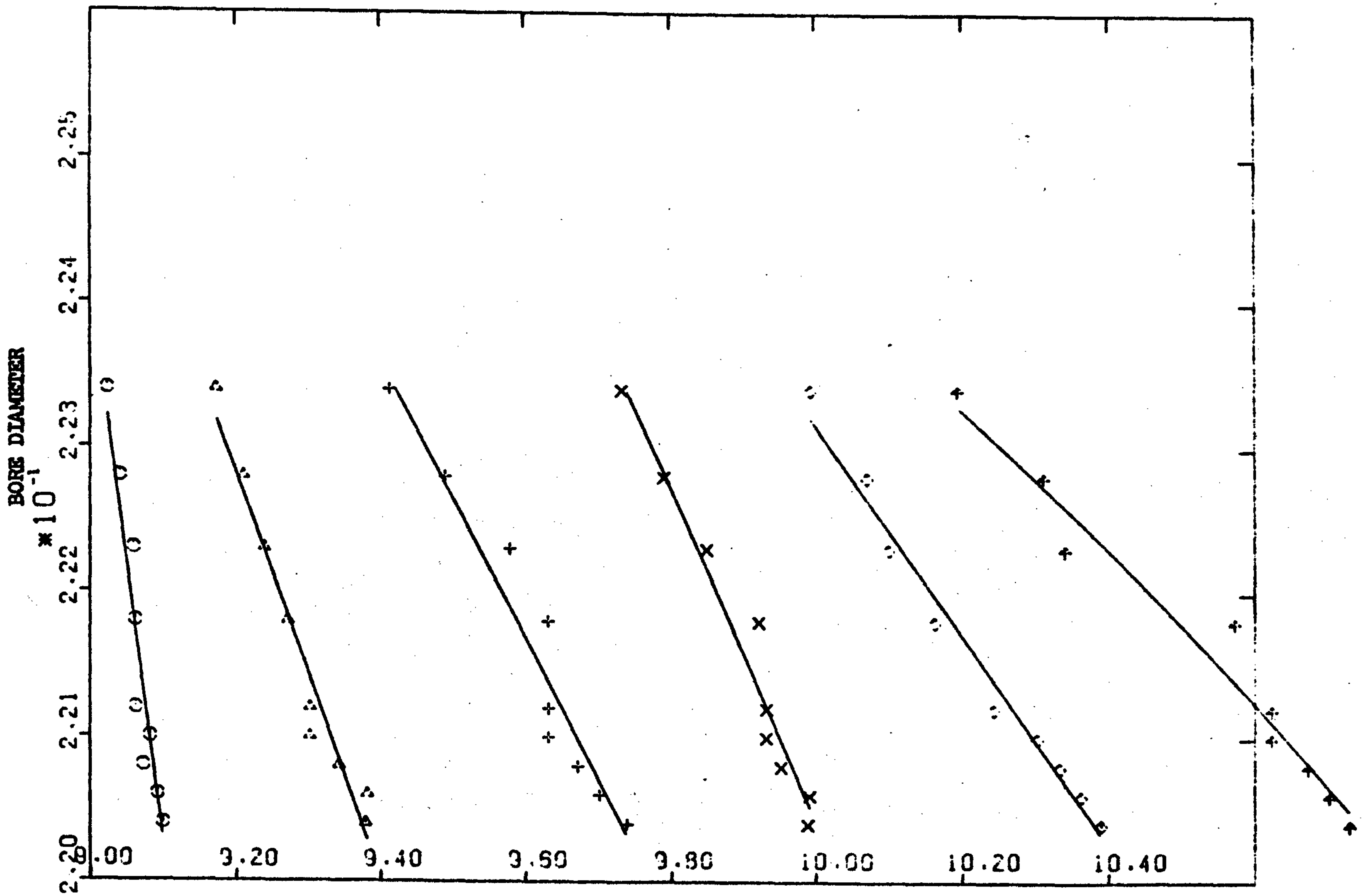


FIGURE 57 - Variation of Bore Shape for Gun Number 2

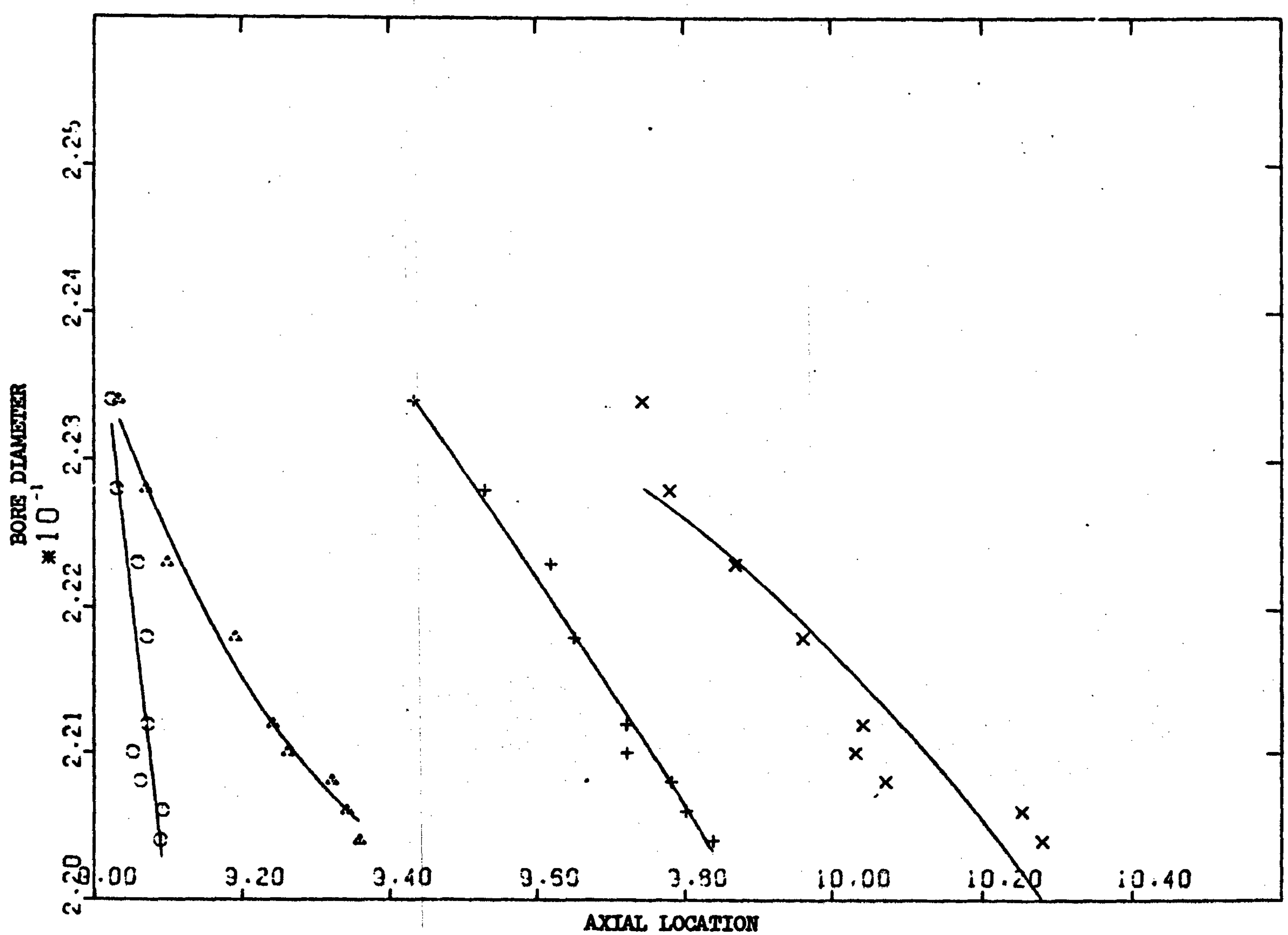


FIGURE 58 - Variation of Bore Shape for Gun Number 3

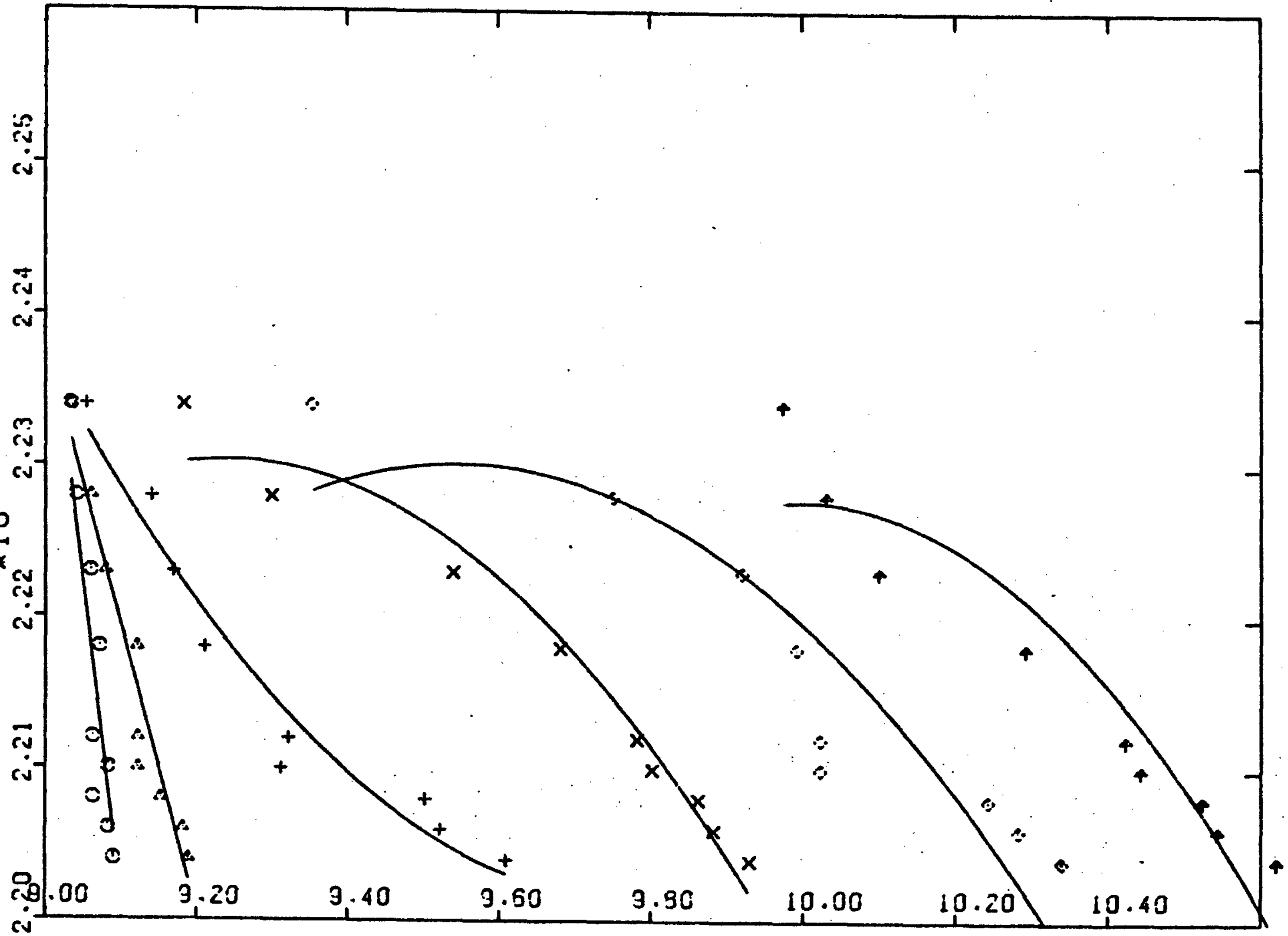


FIGURE 59 - Variation of Bore Shape for Gun Number 4

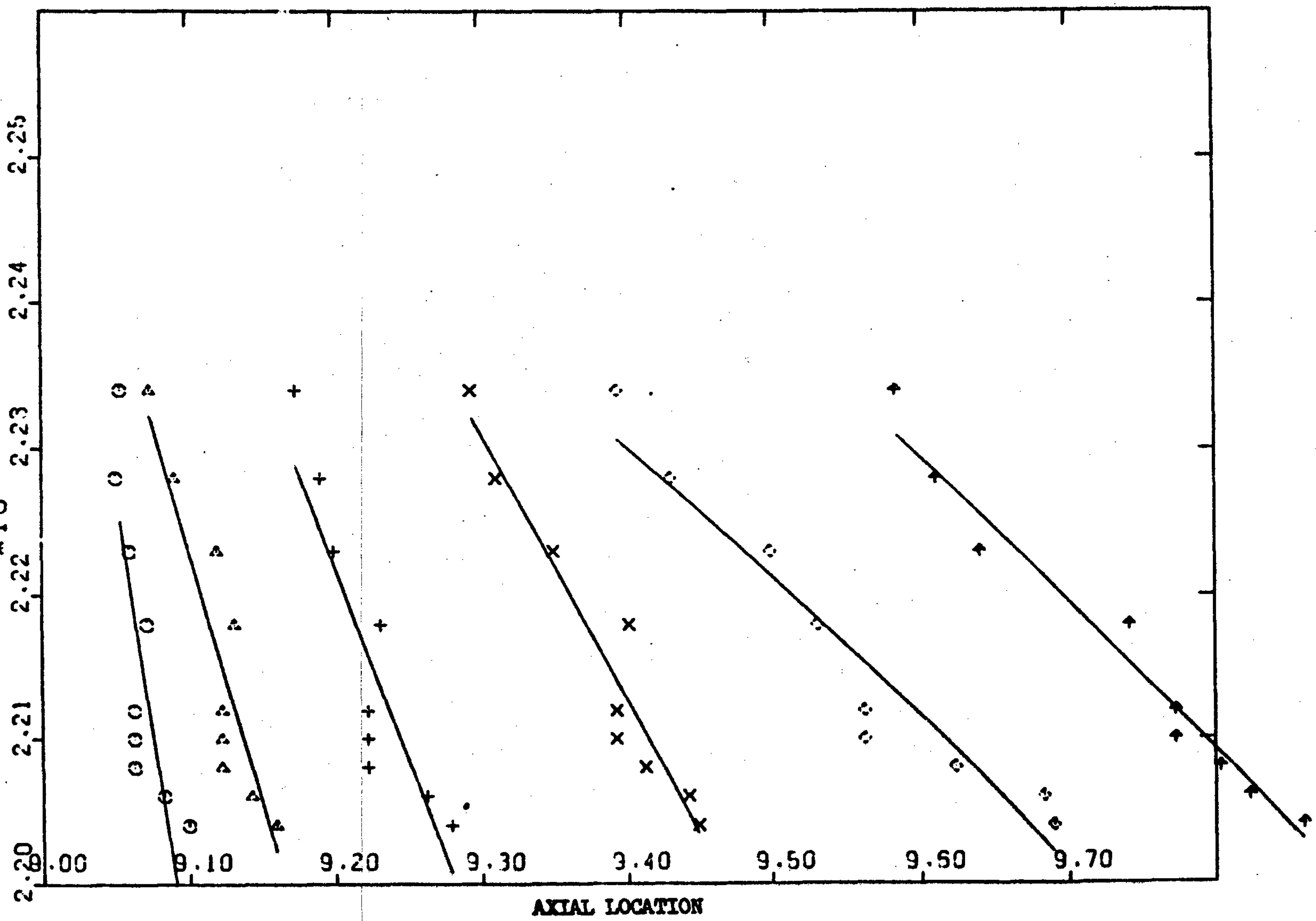


FIGURE 60 - Variation of Bore Shape for Gun Number 5

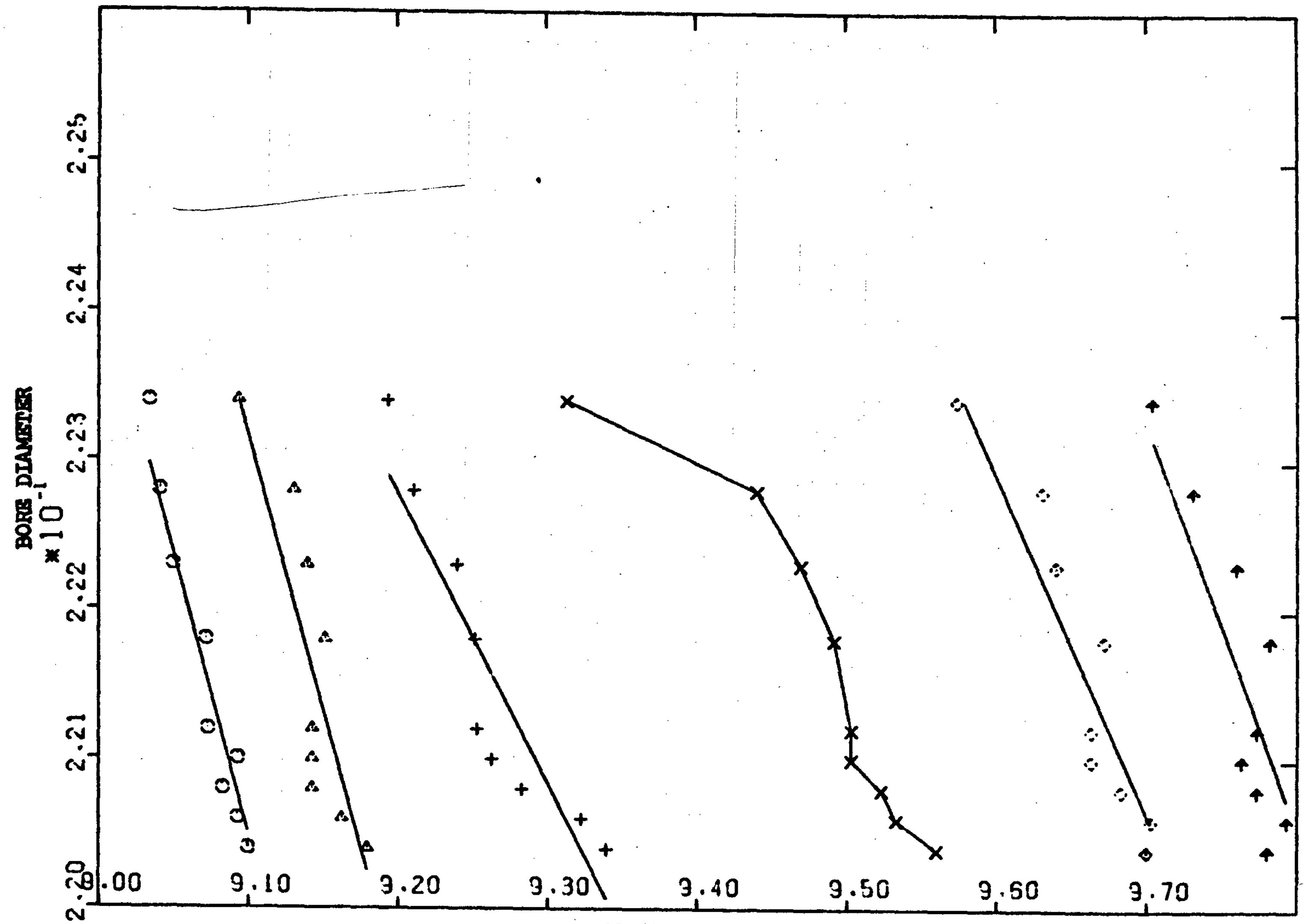


FIGURE 61 - Variation of Bore Shape for Gun Number 6

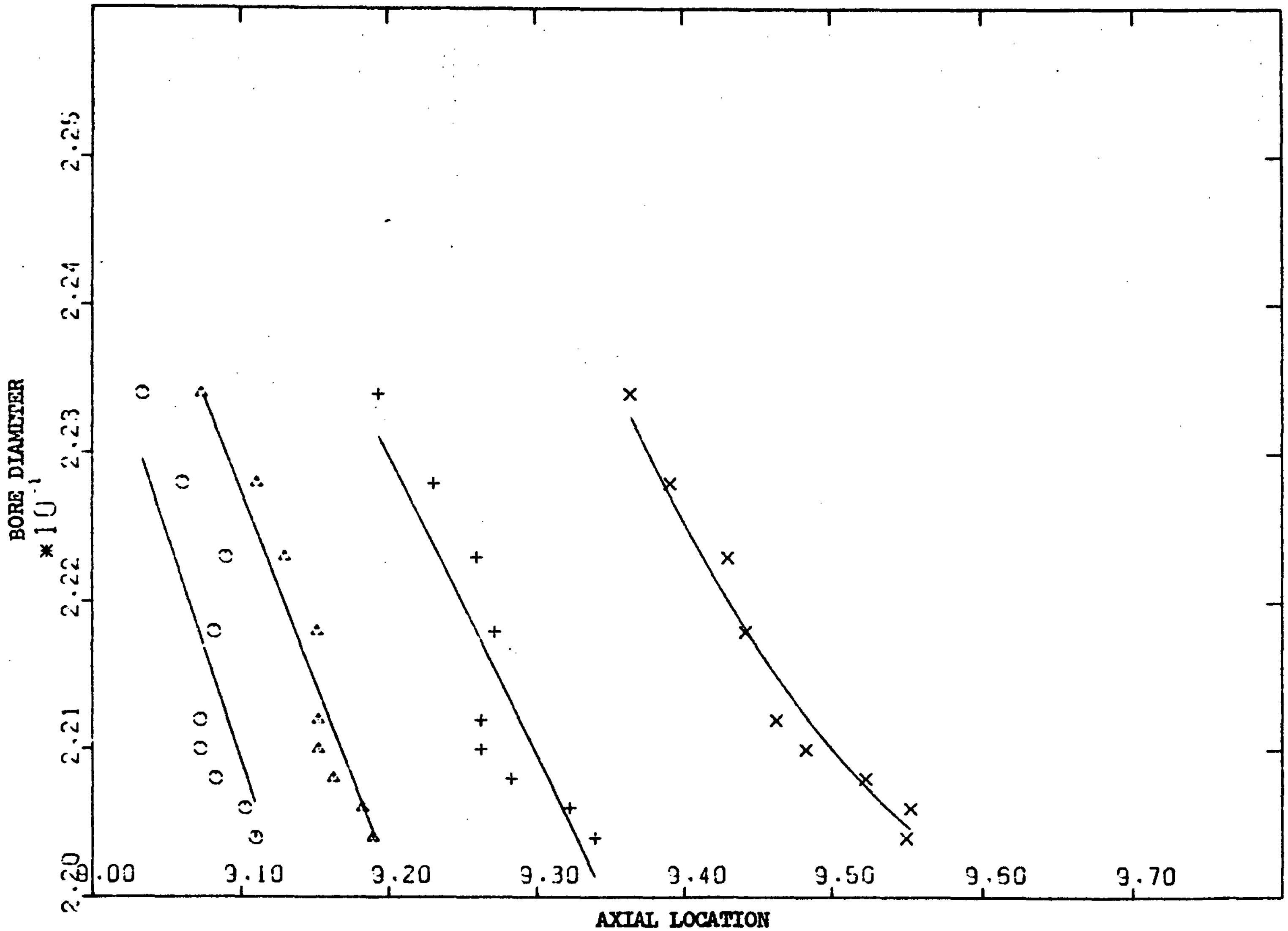


FIGURE 62 - Variation of Bore Shape for Gun Number 7

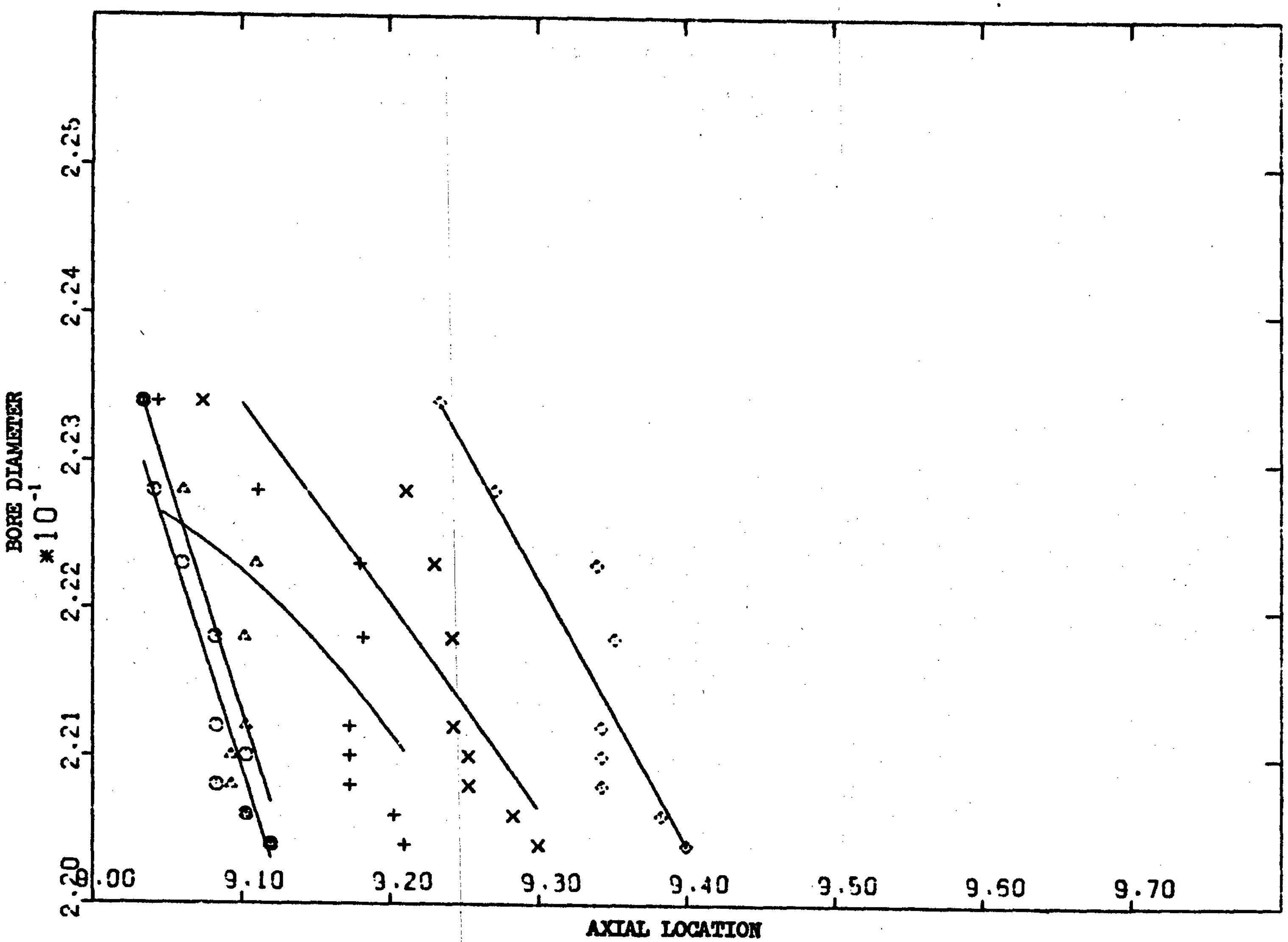


FIGURE 63 - Variation of Bore Shape for Gun Number 8

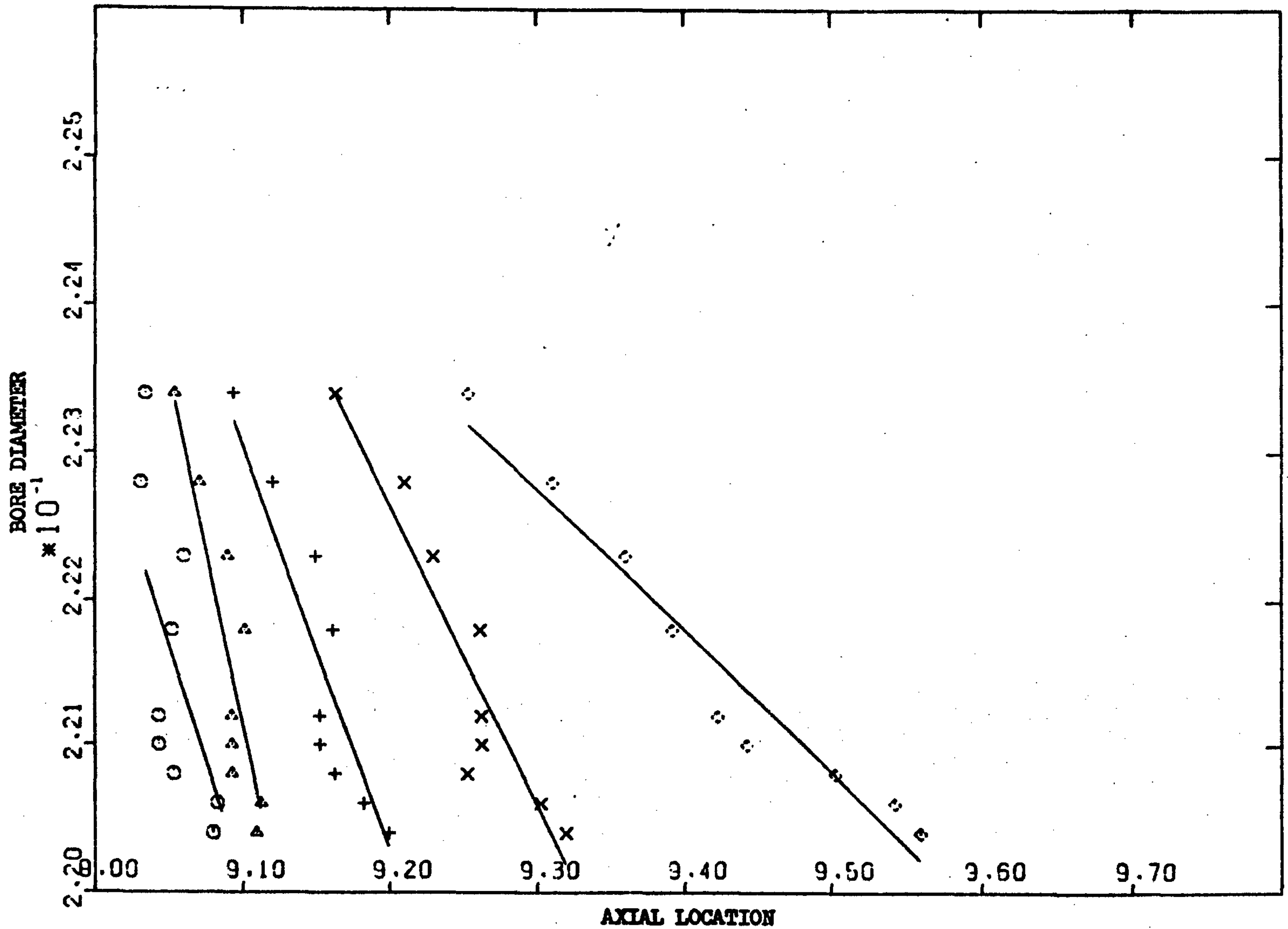


FIGURE 64 - Variation of Bore Shape for Gun Number 9

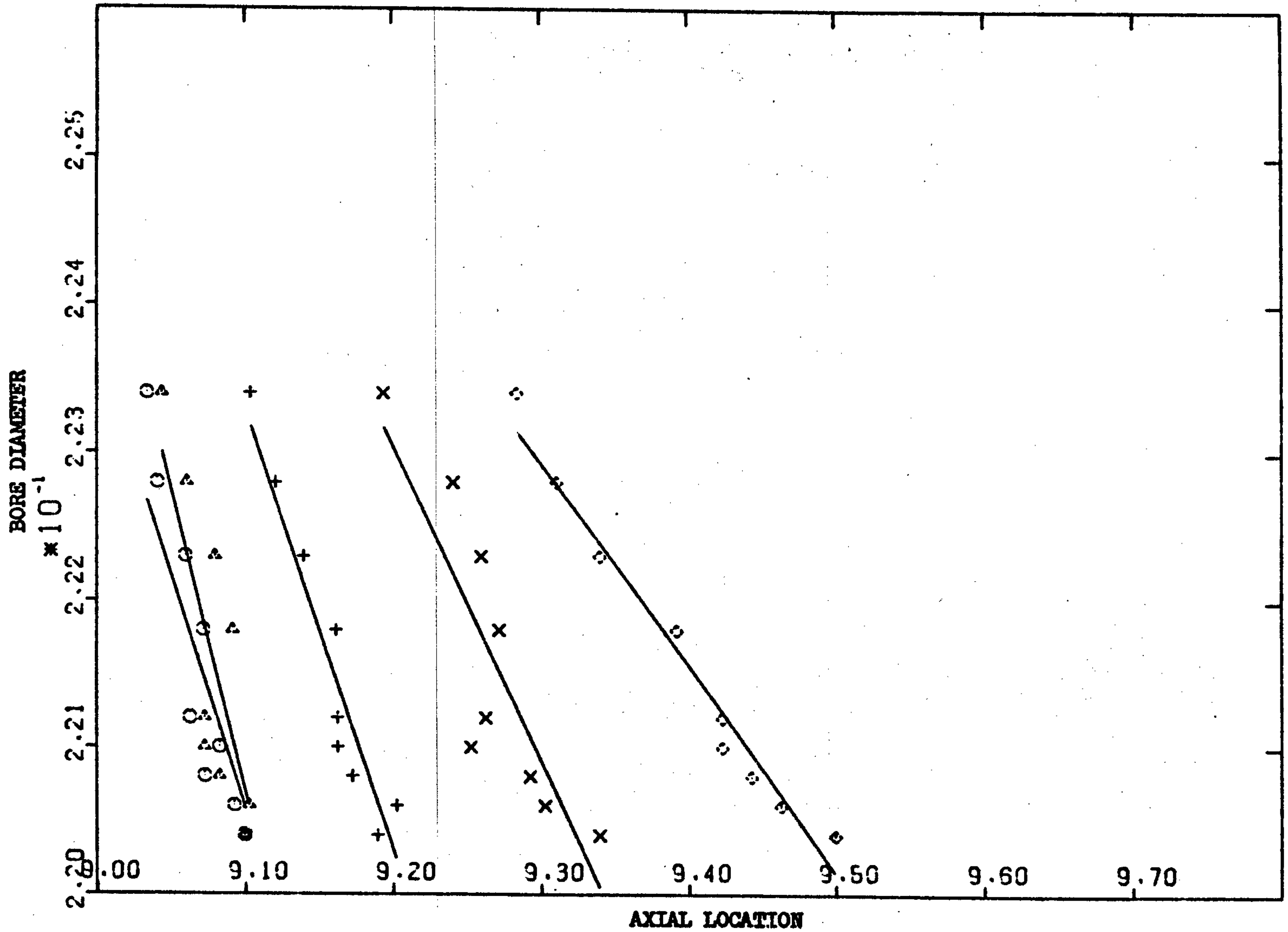


FIGURE 65 - Variation of Bore Shape for Gun Number 10

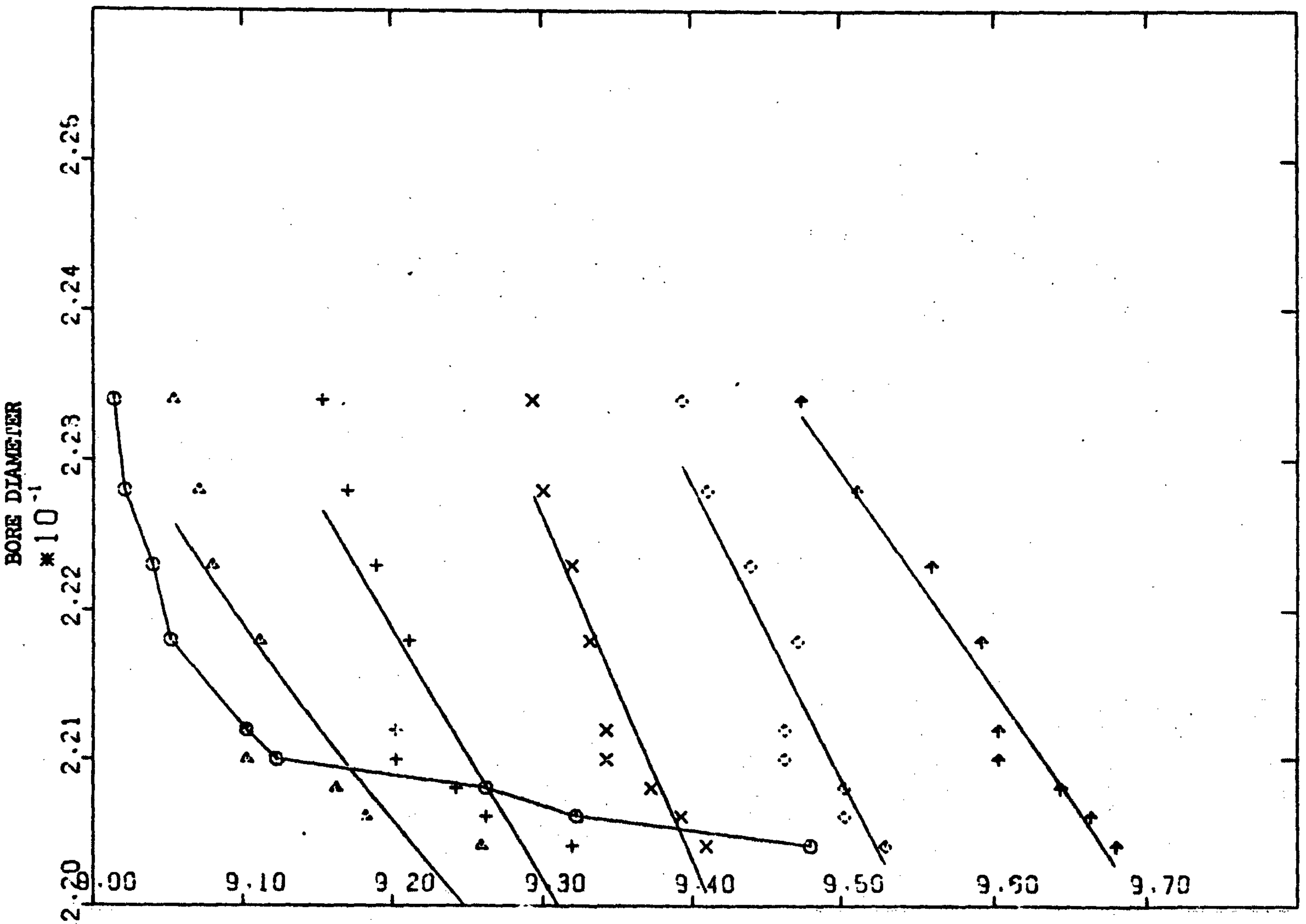


FIGURE 66 - Variation of Bore Shape for Gun Number 11

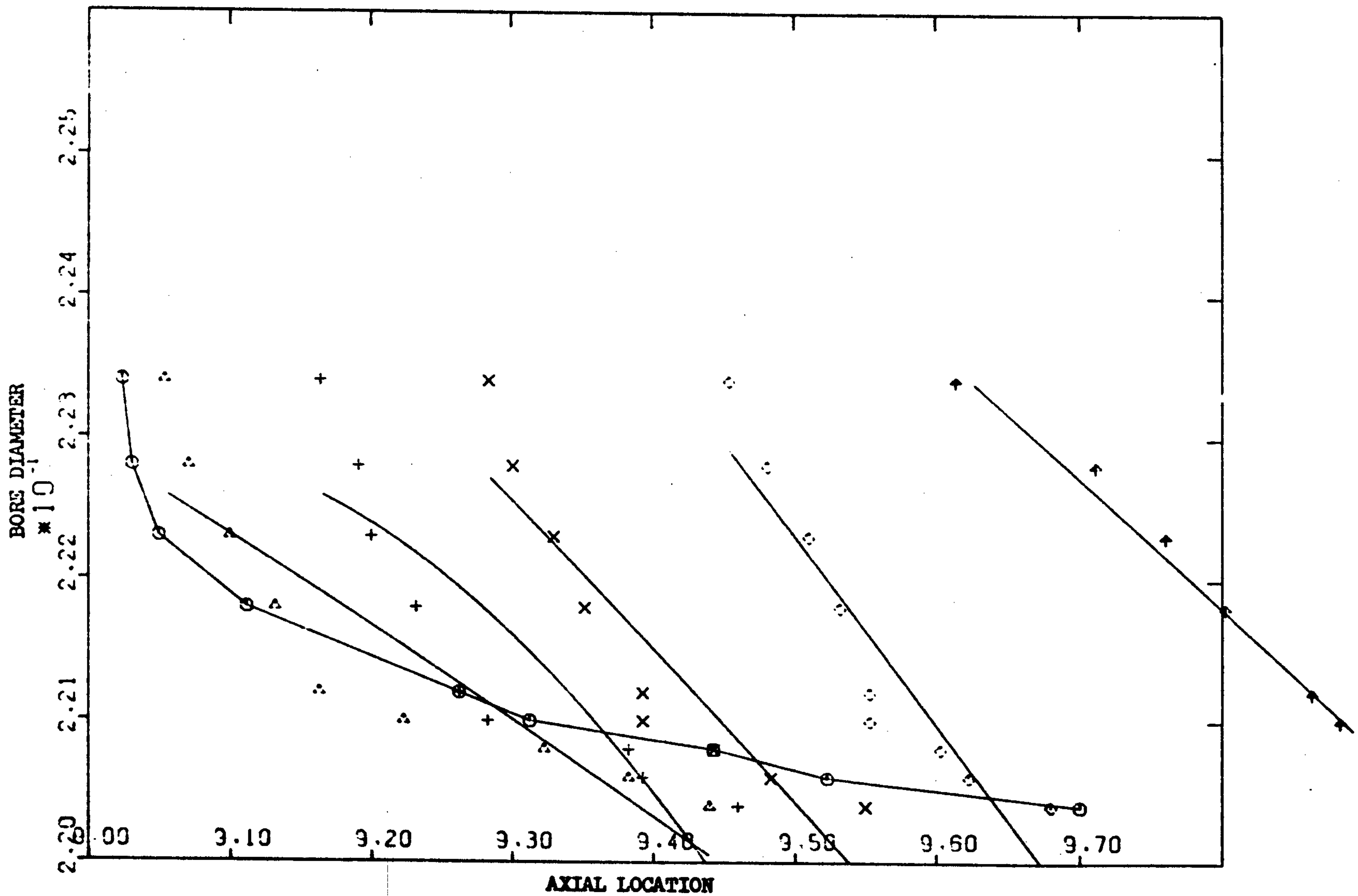


FIGURE 67- Variation of Bore Shape for Gun Number 12

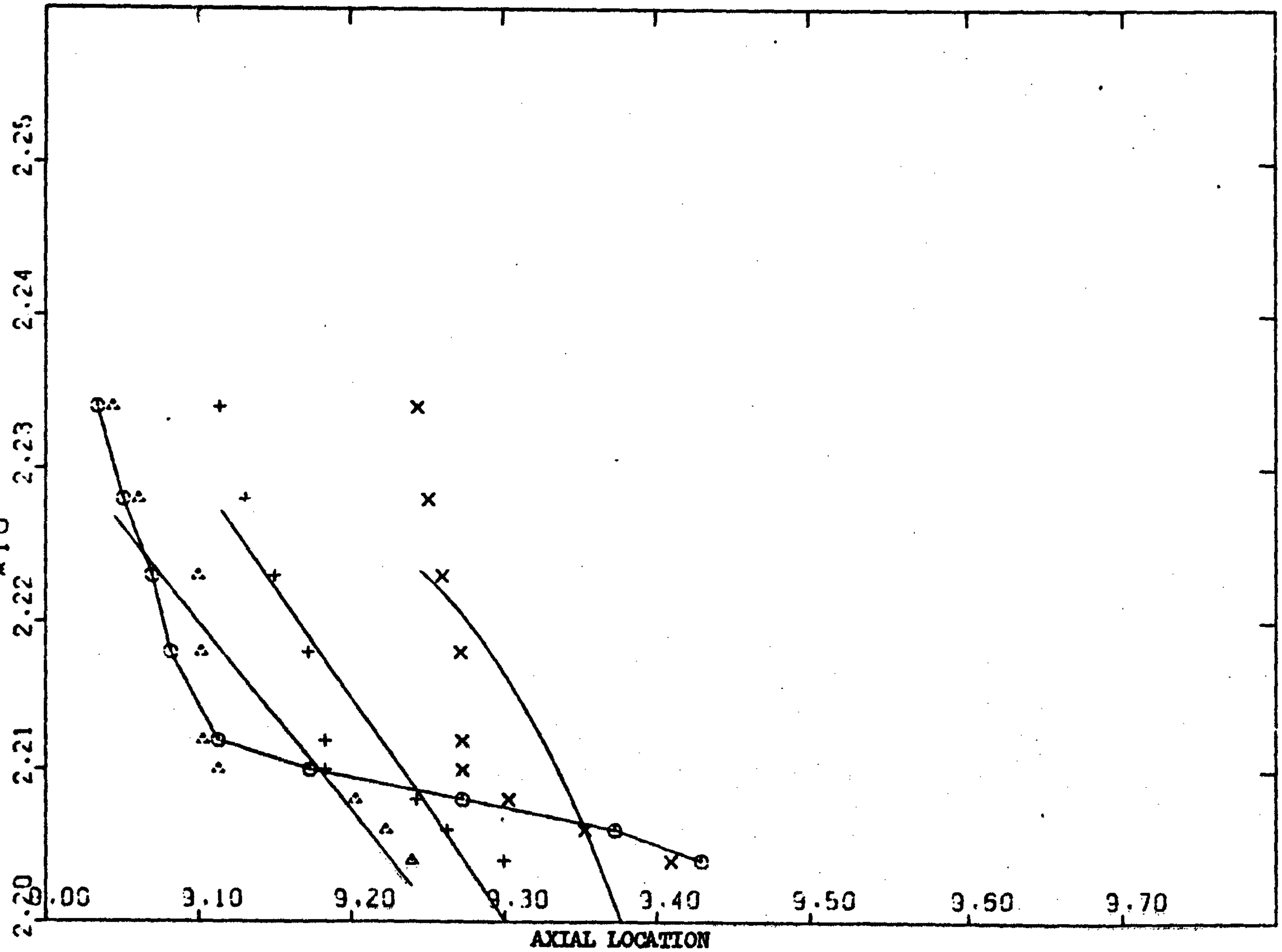


FIGURE 68 - Variation of Bore Shape for Gun Number 13

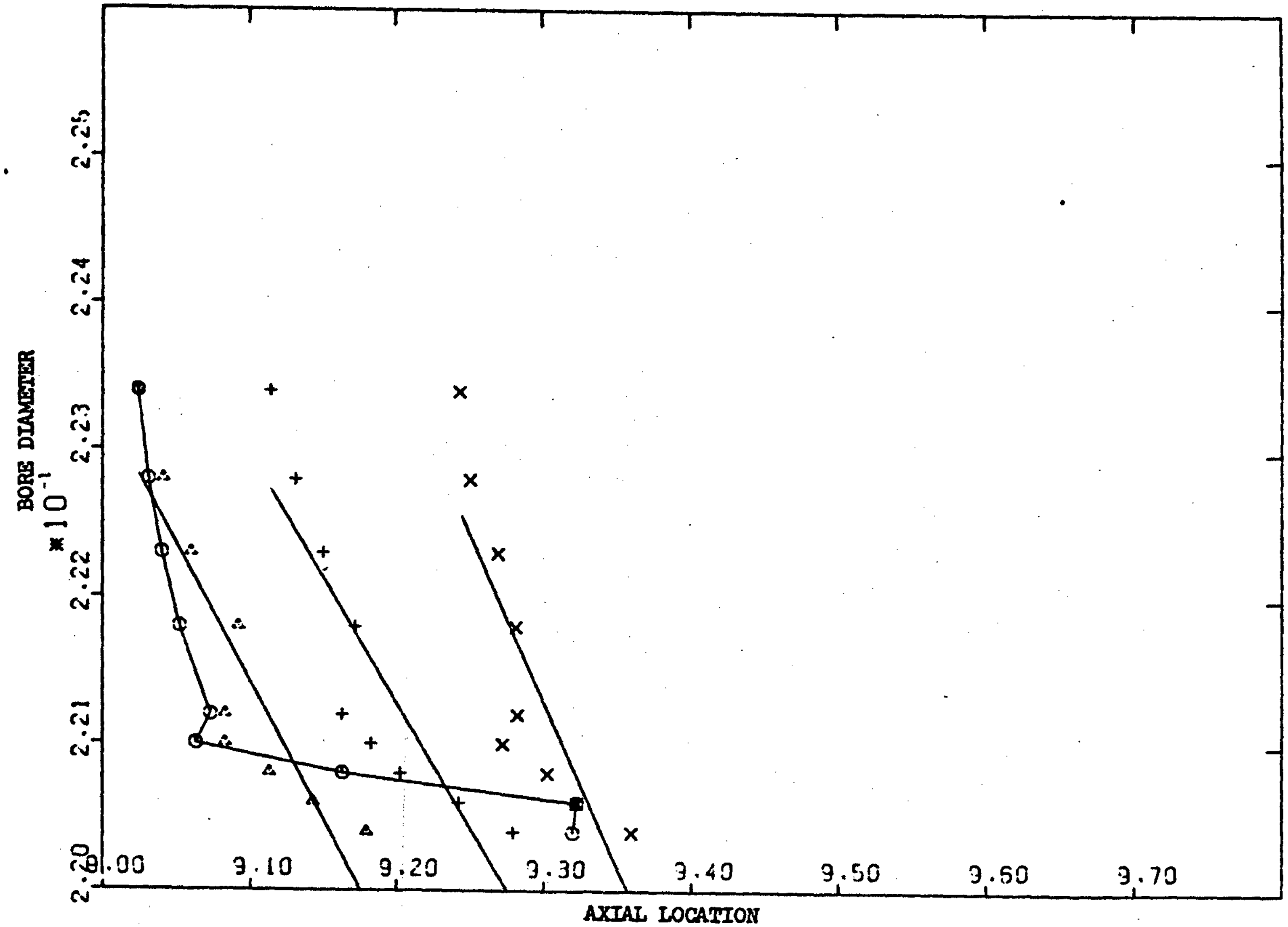


FIGURE 69 - Variation of Bore Shape for Gun Number 14

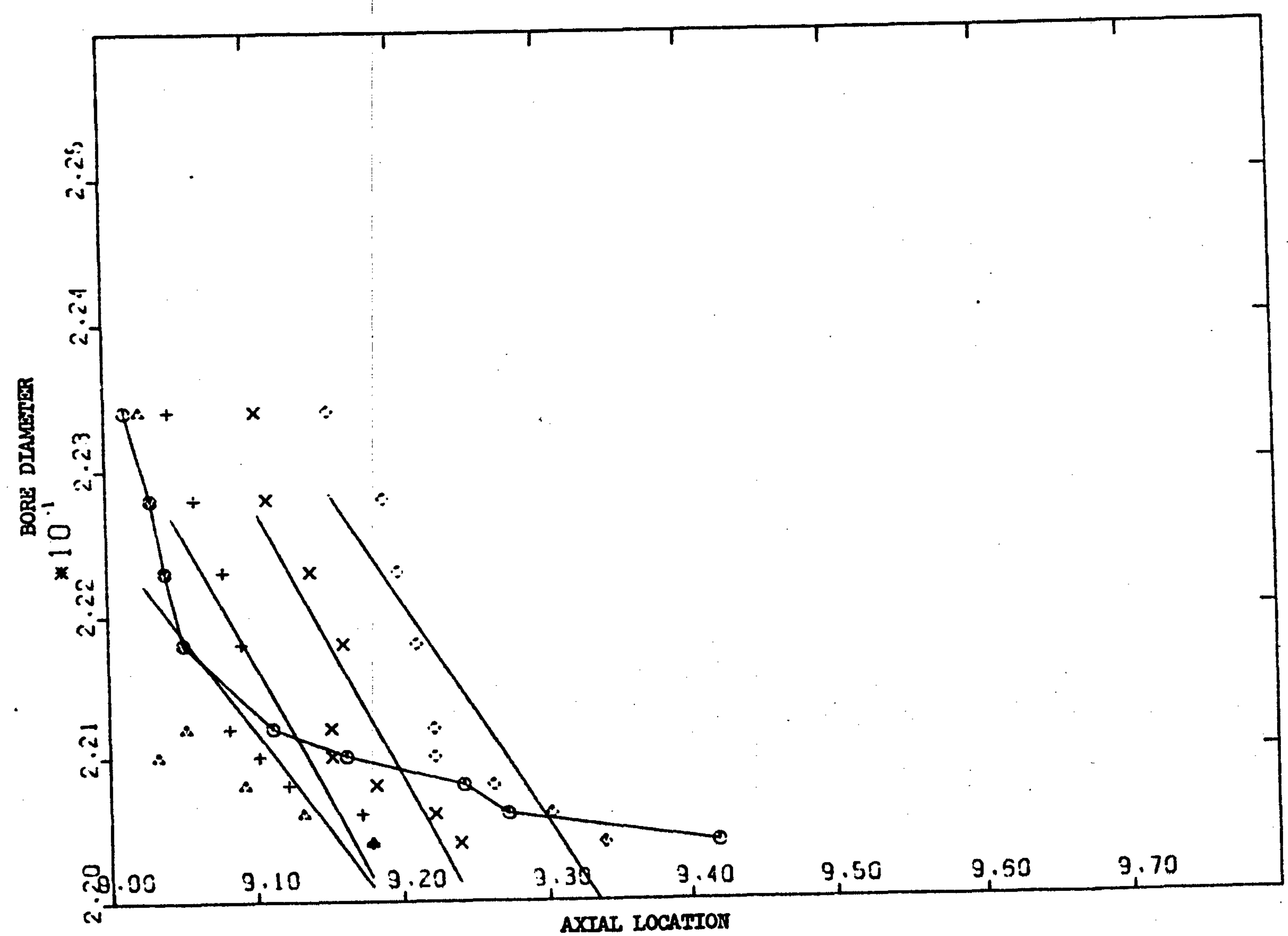


FIGURE 70 - Variation of Bore Shape for Gun Number 15

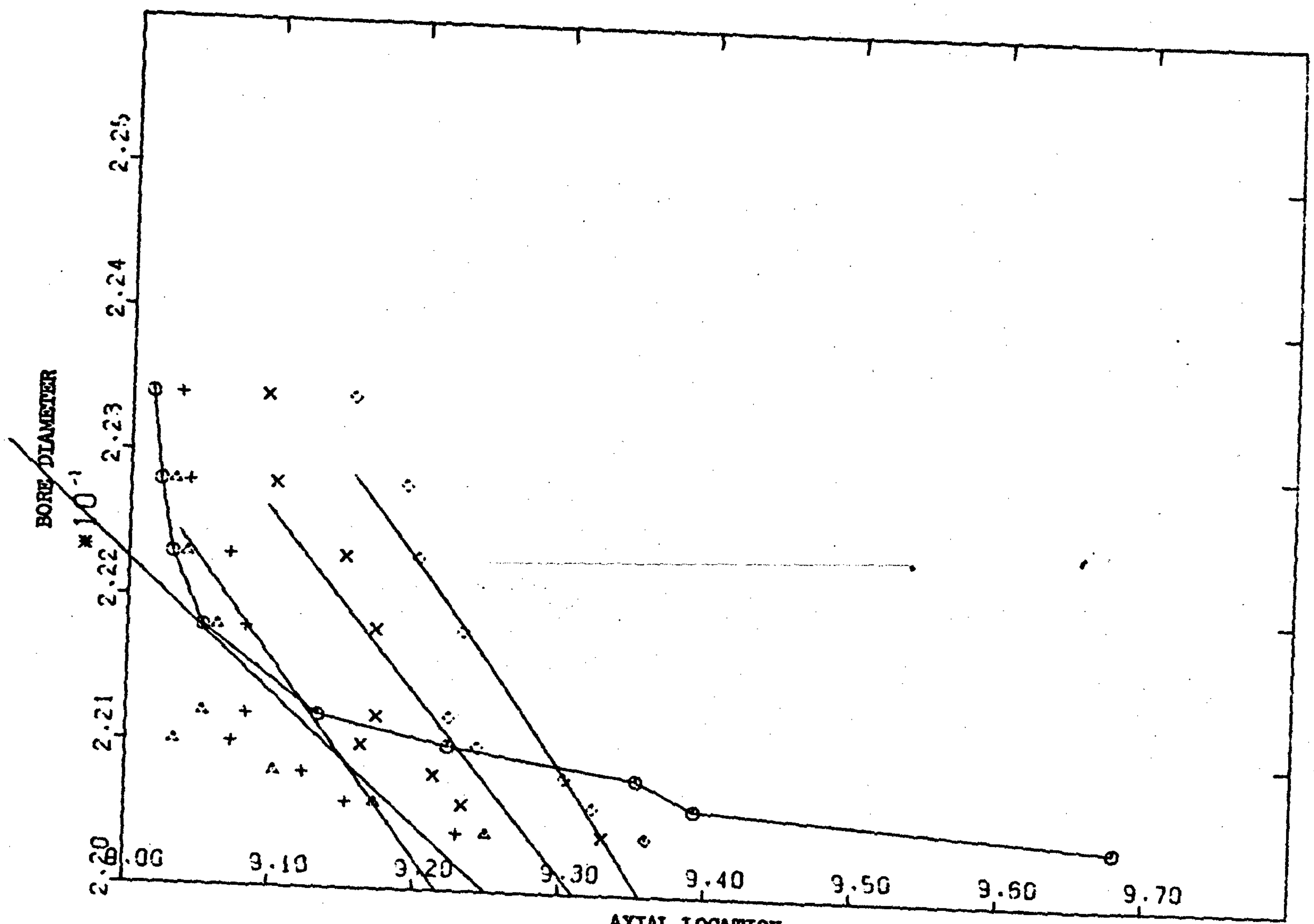


FIGURE 71 - Variation of Bore Shape for Gun Number 16

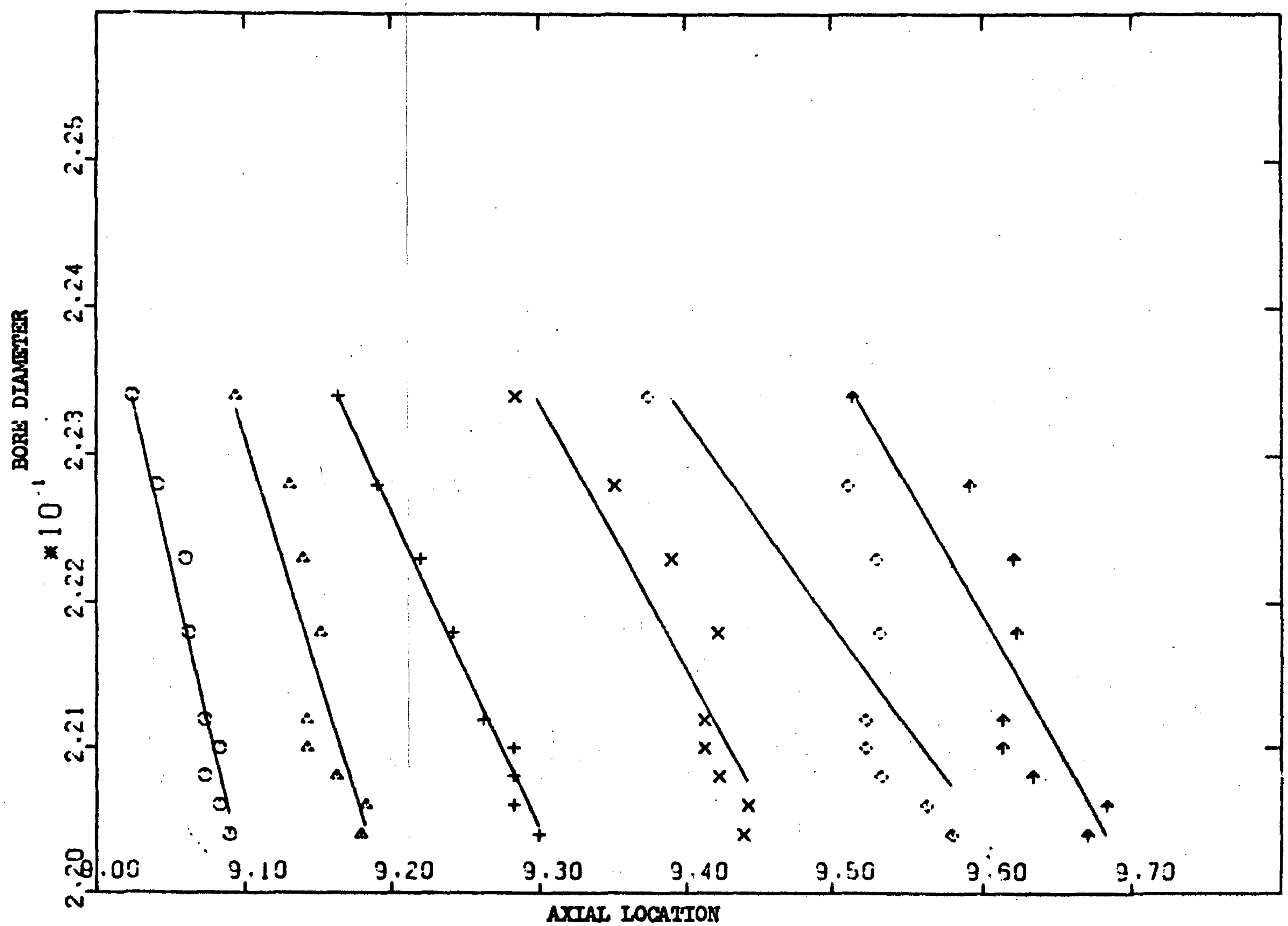


FIGURE 72 - Variation of Bore Shape for Gun Number 17

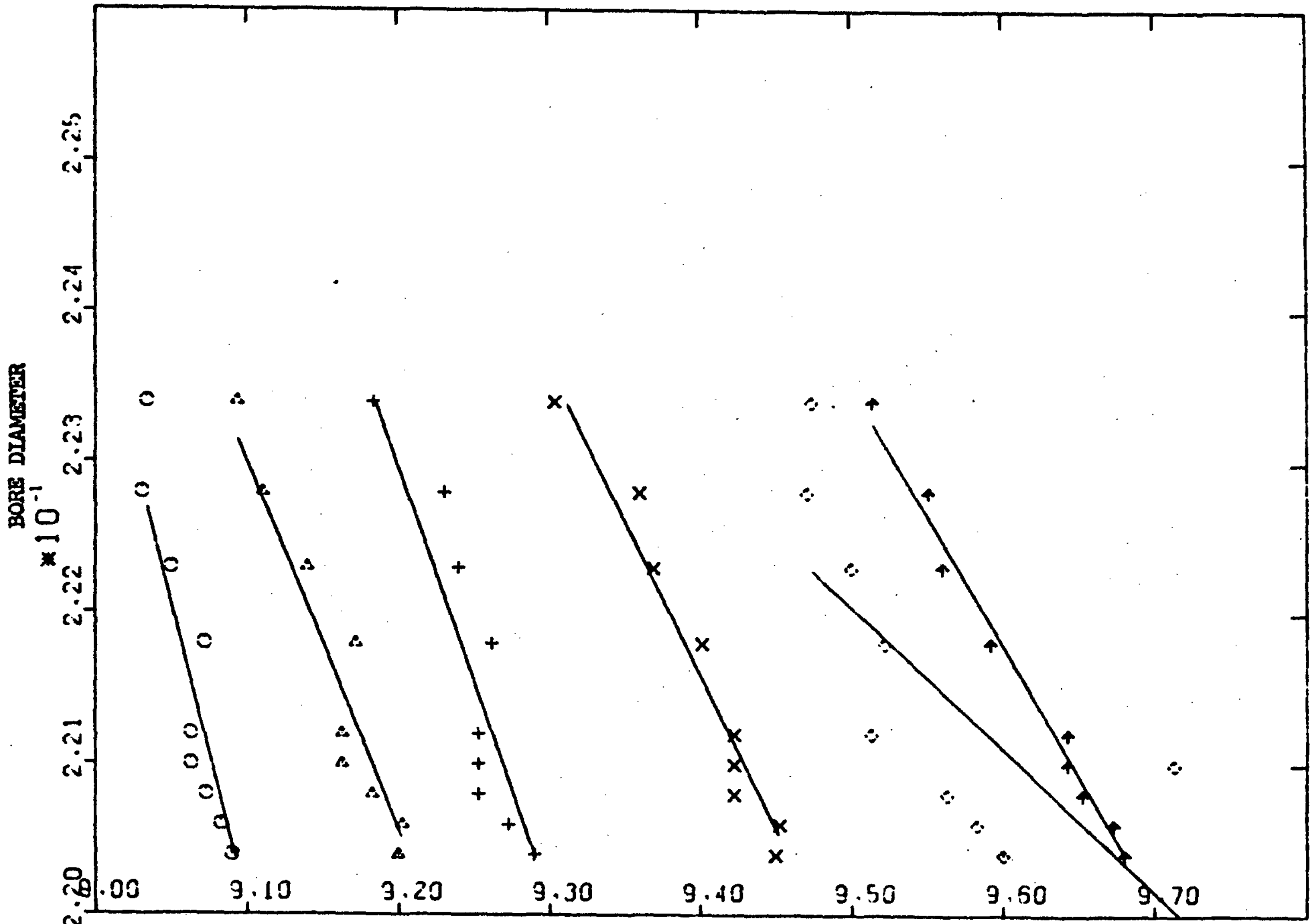


FIGURE 73 - Variation of Bore Shape for Gun Number 18

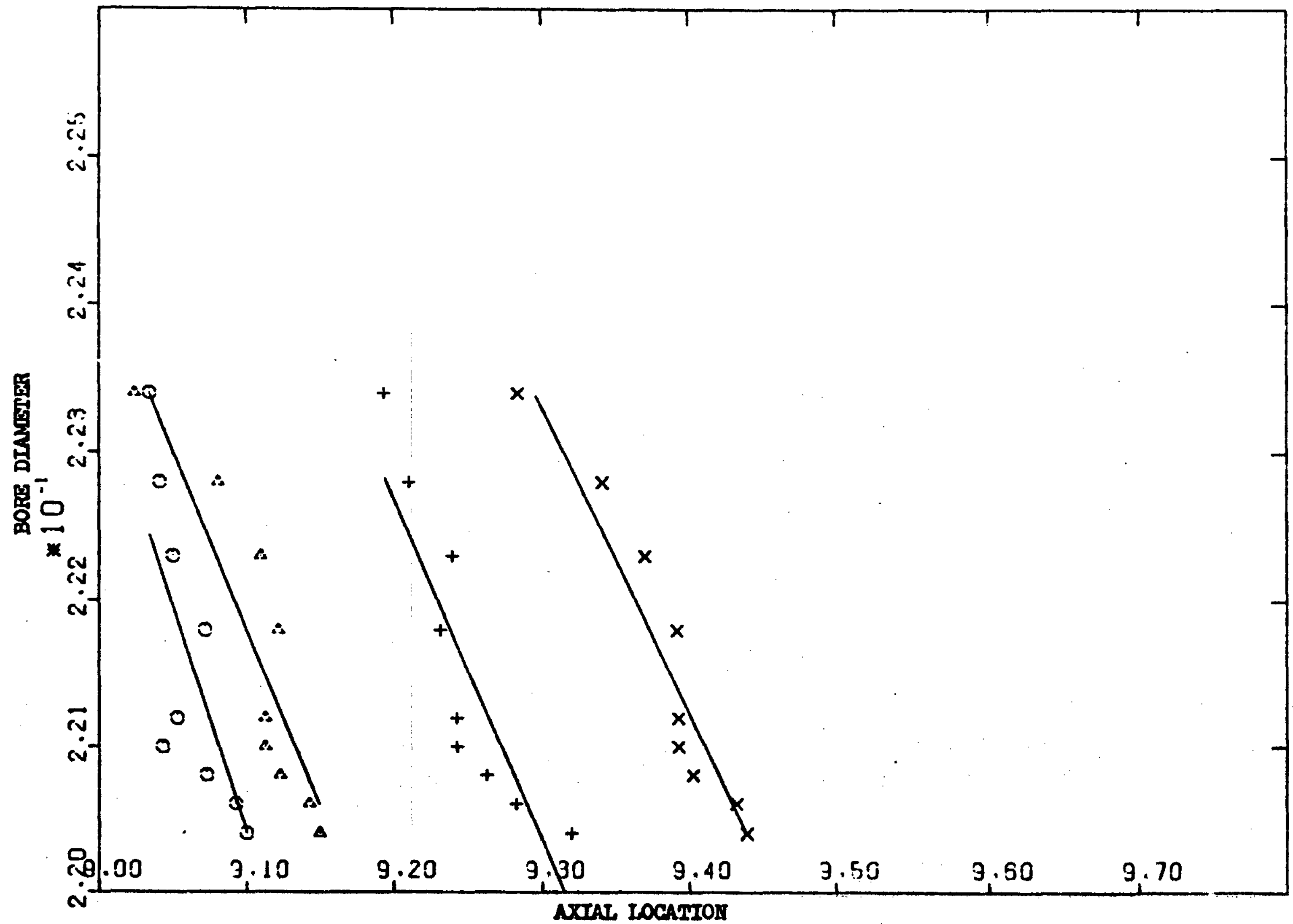


FIGURE 74 - Variation of Bore Shape for Gun Number 19

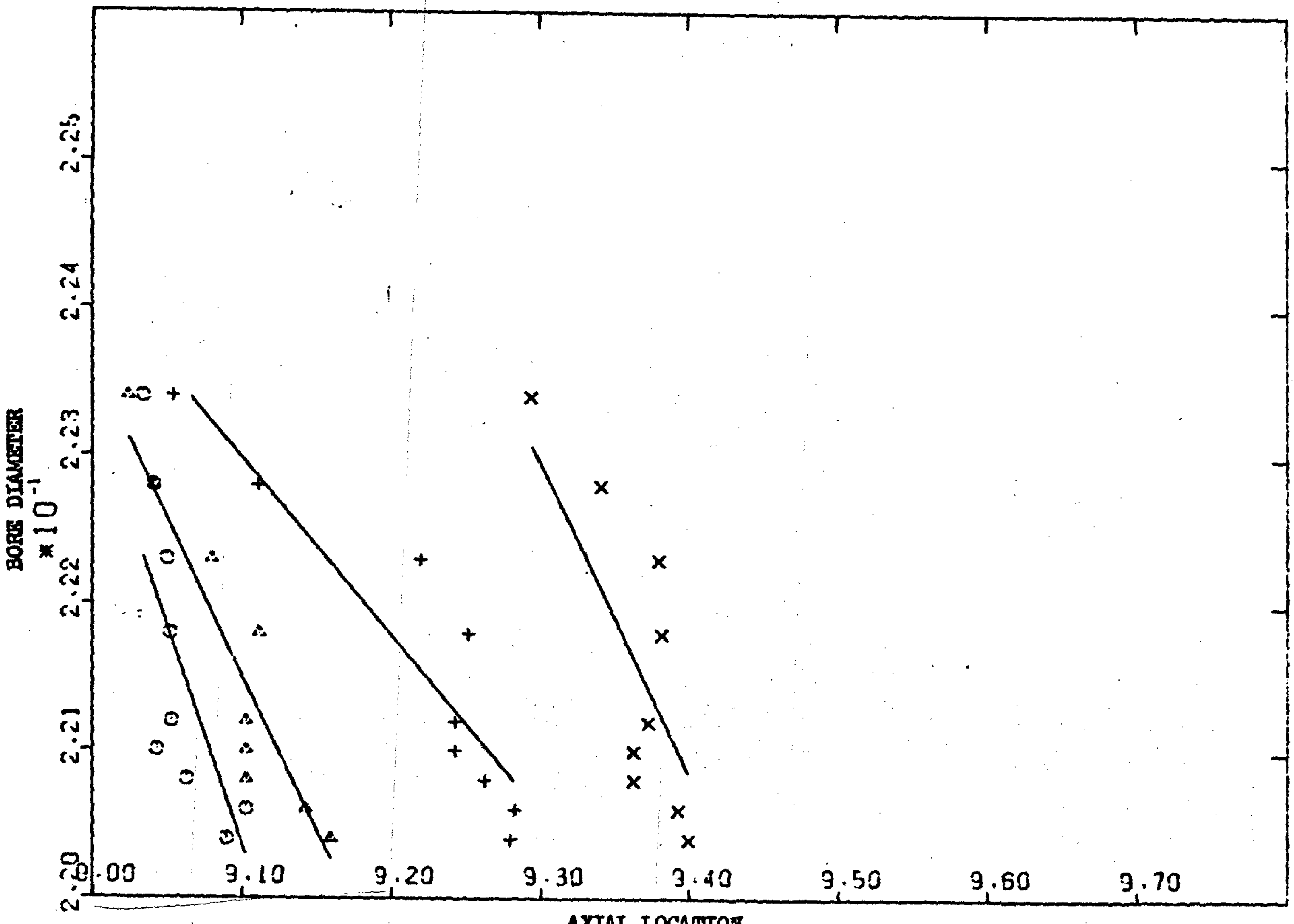


FIGURE 75 - Variation of Bore Shape for Gun Number 20

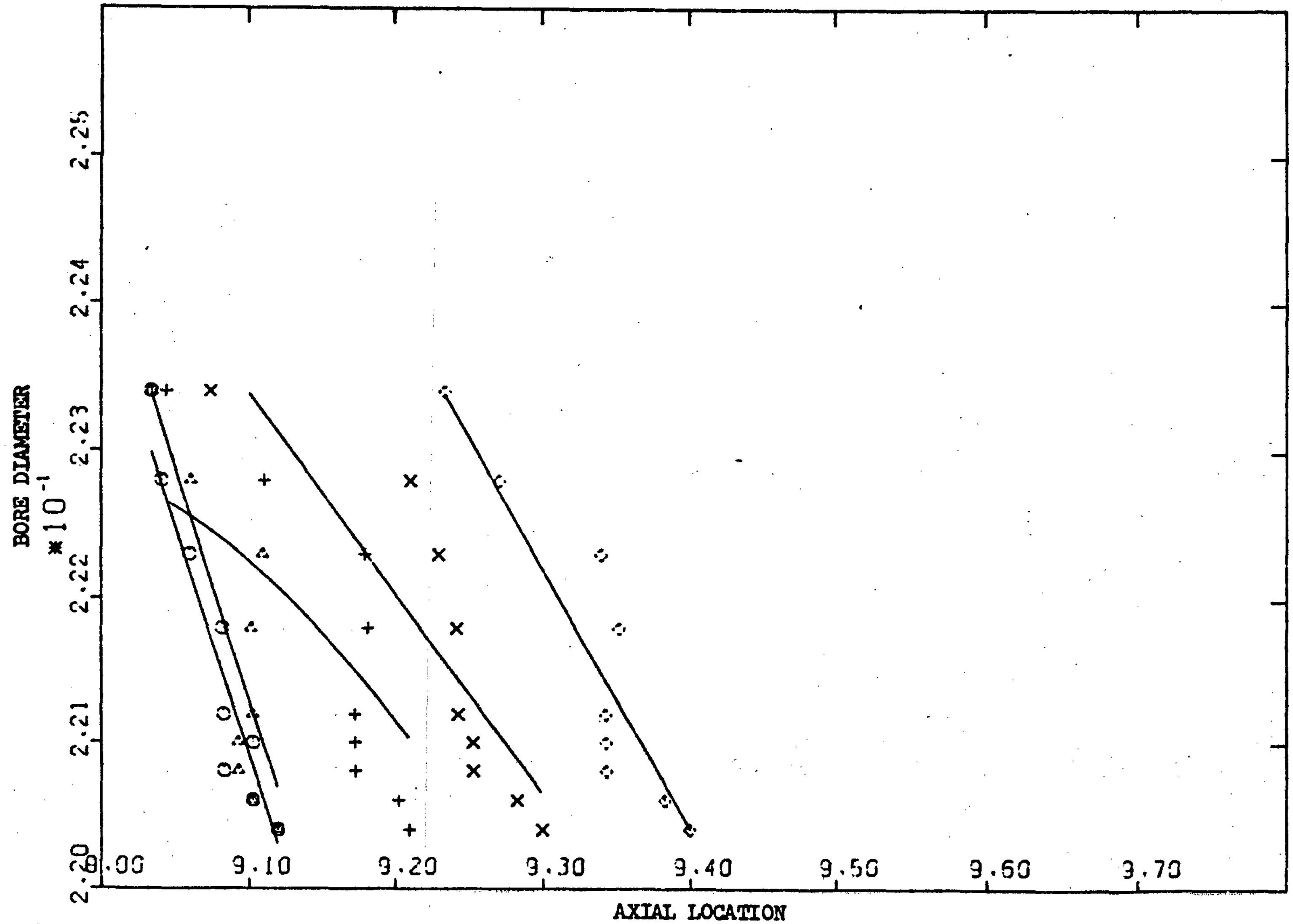


FIGURE 76 - Variation of Bore Shape for Gun Number 21

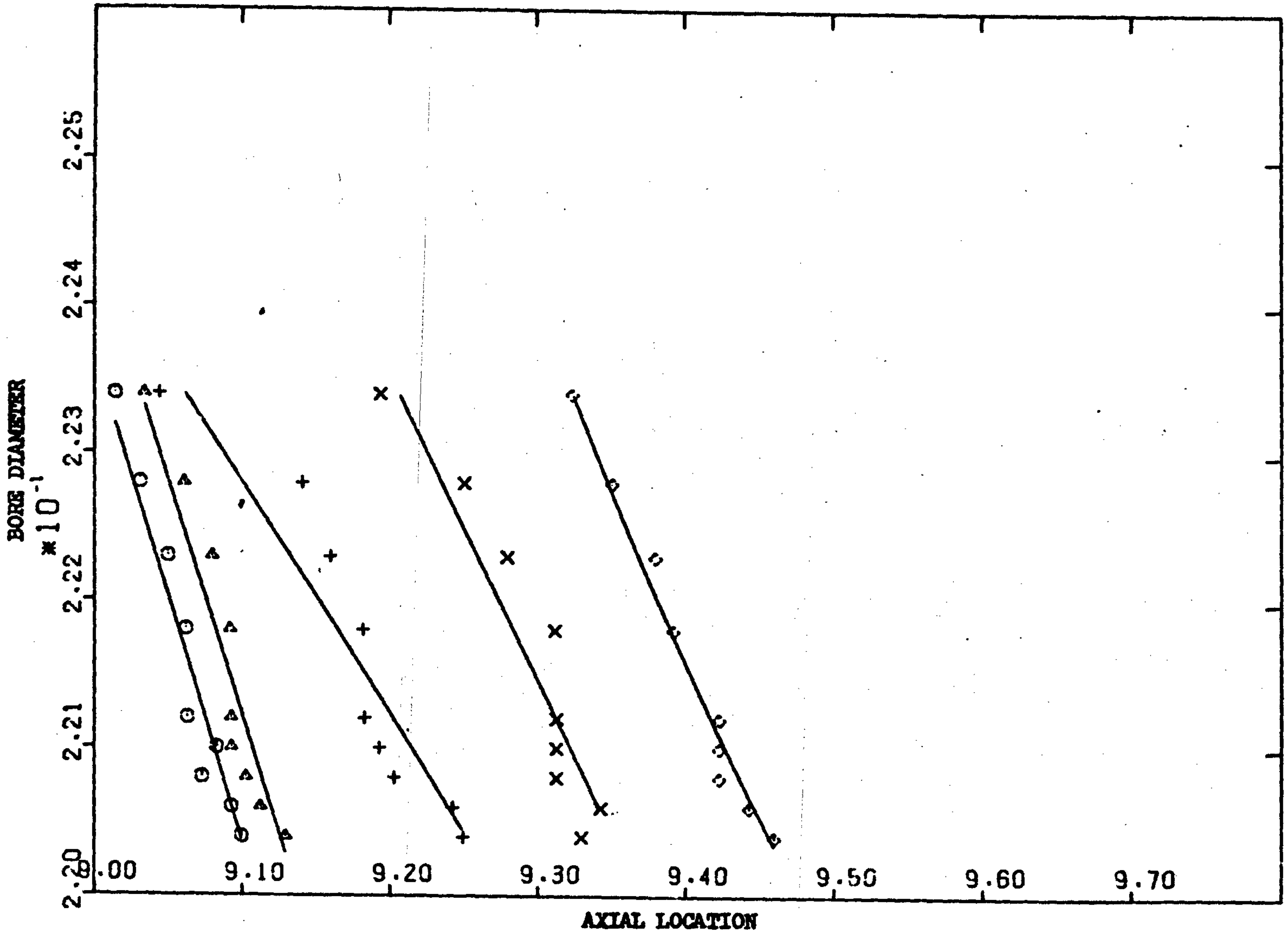


FIGURE 77 - Variation of Bore Shape for Gun Number 22

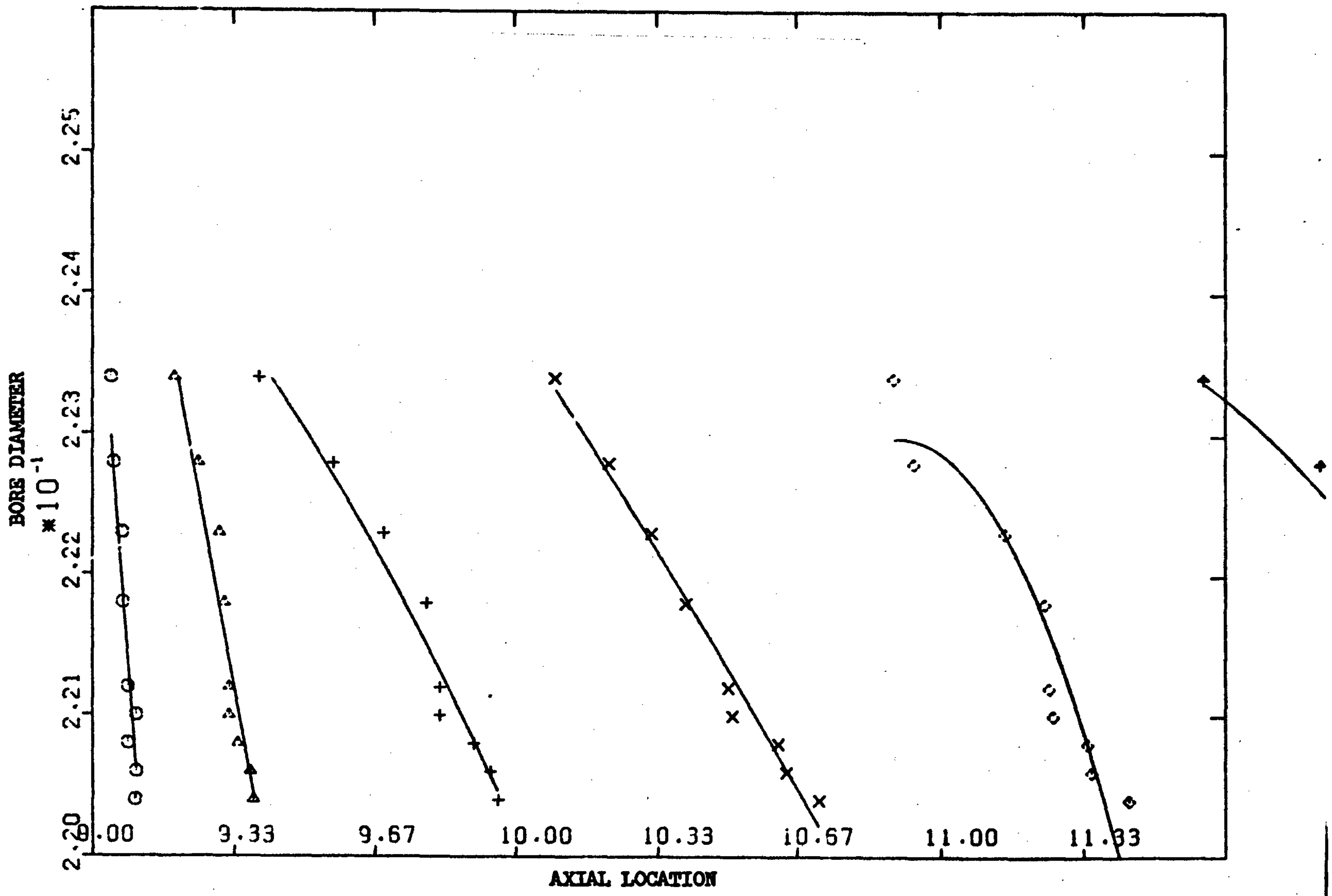


FIGURE 78 - Variation of Bore Shape for Gun Number 23

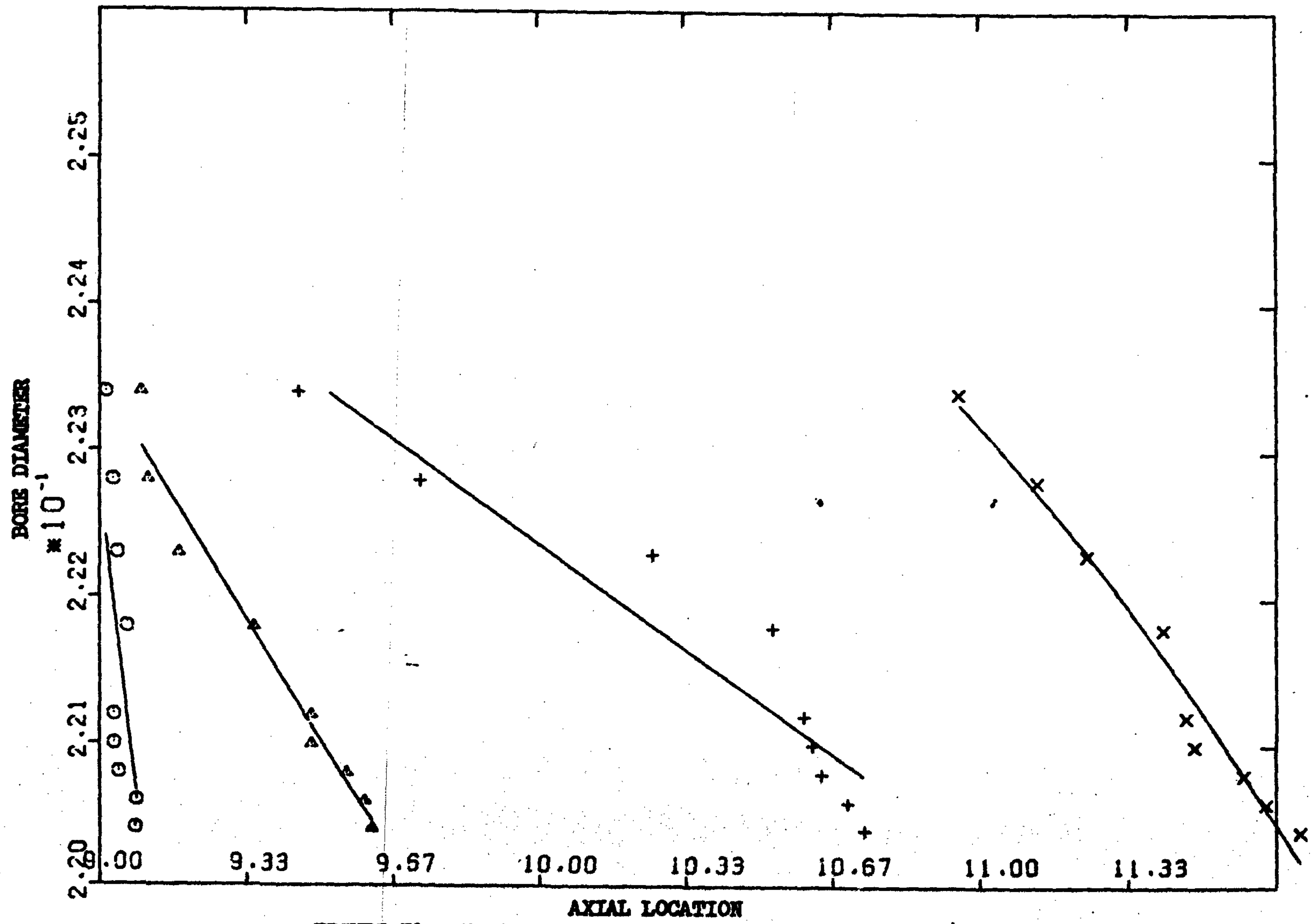


FIGURE 79 - Variation of Bore Shape for Gun Number 24

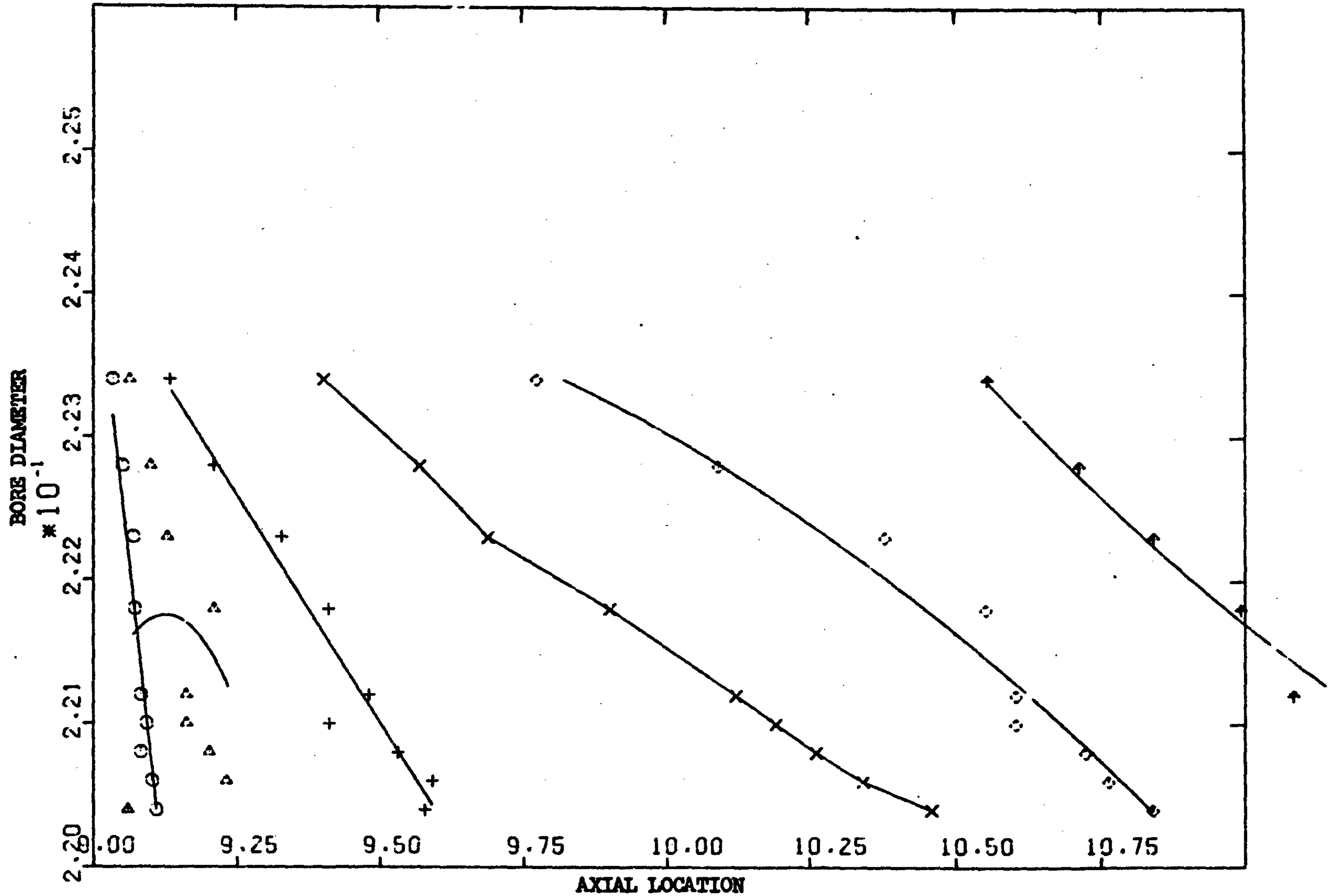


FIGURE 80 - Variation of Bore Shape for Gun Number 25

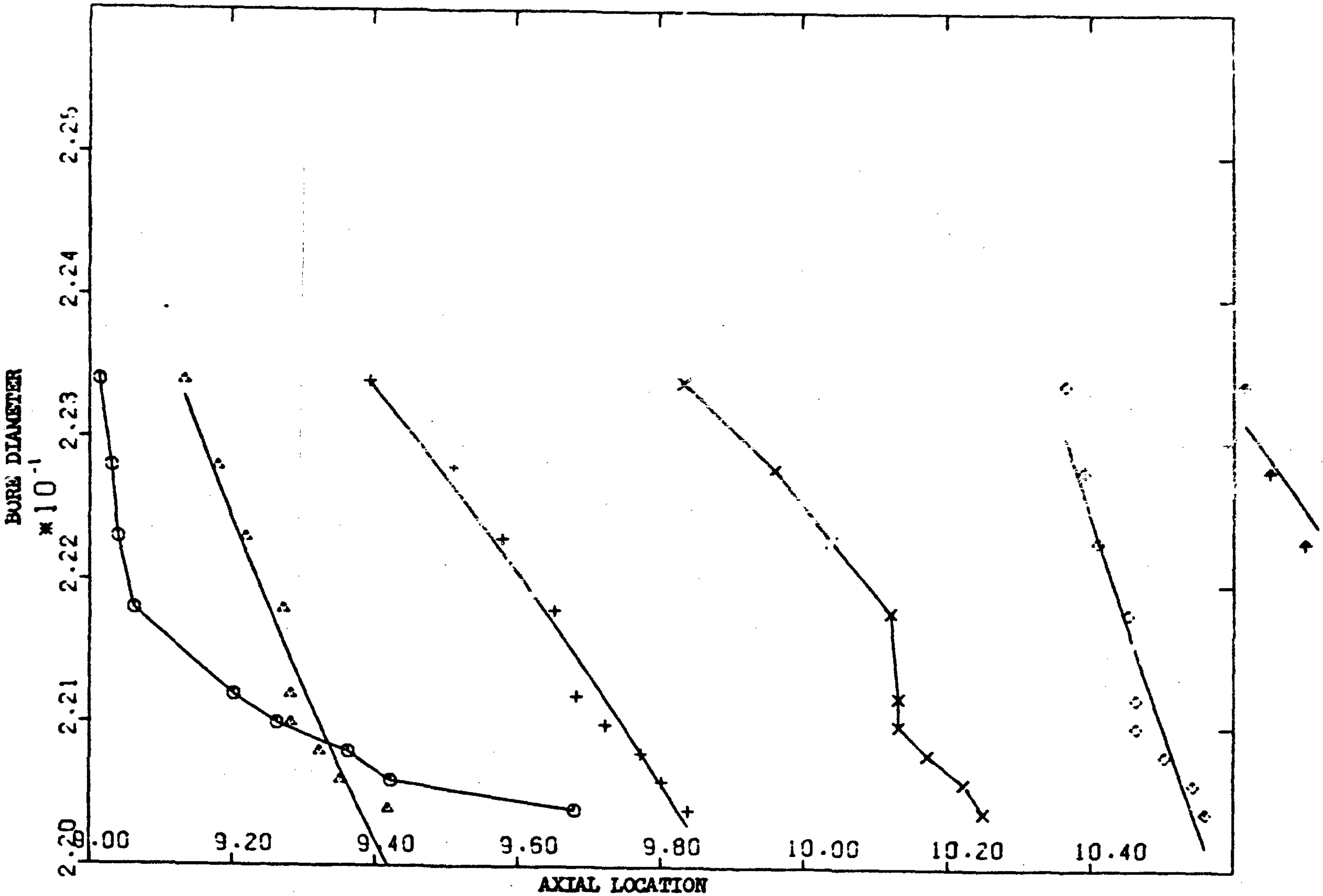


FIGURE 81 - Variation of Bore Shape for Gun Number 26

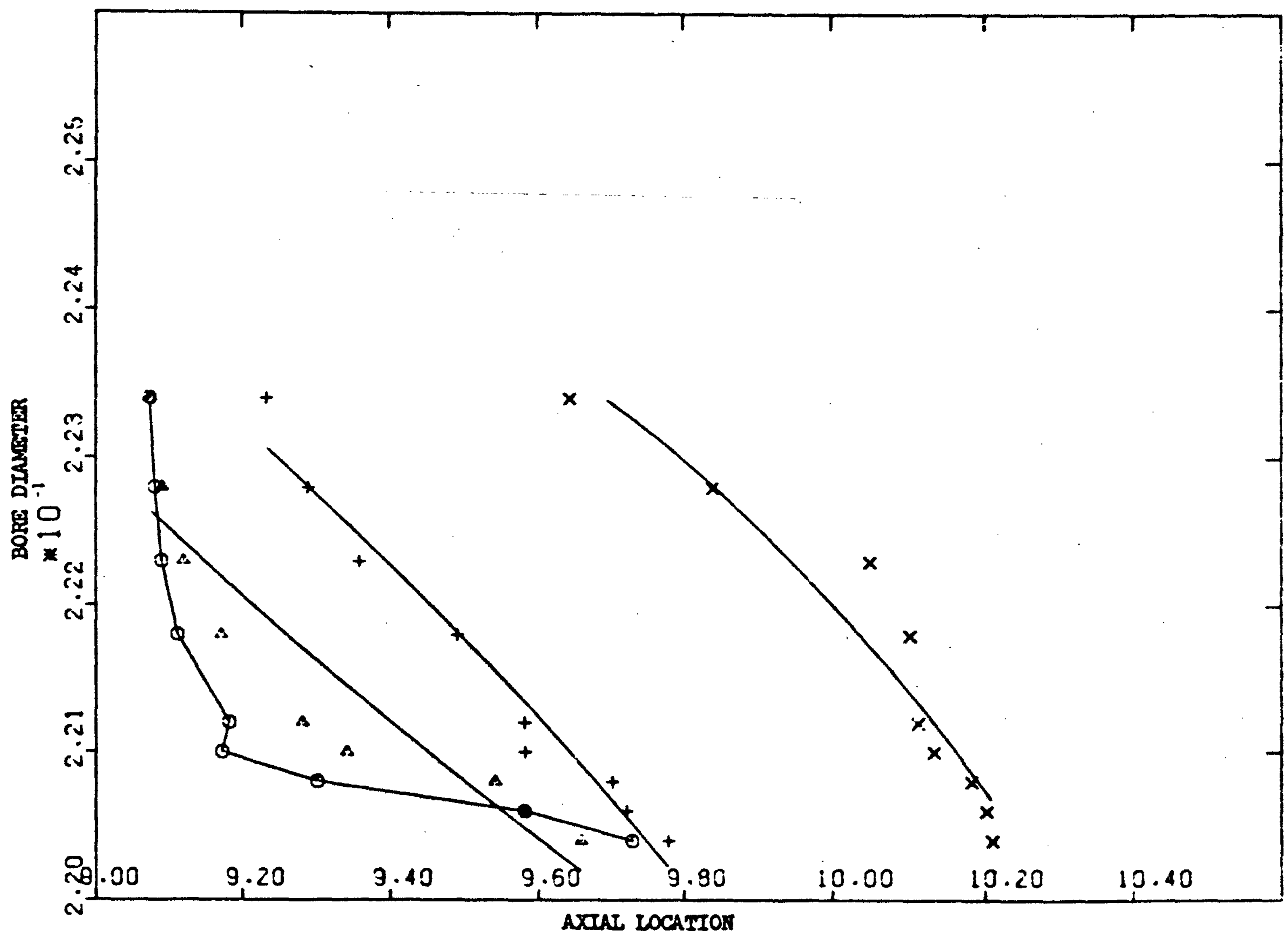


FIGURE 82 - Variation of Bore Shape for Gun Number 27

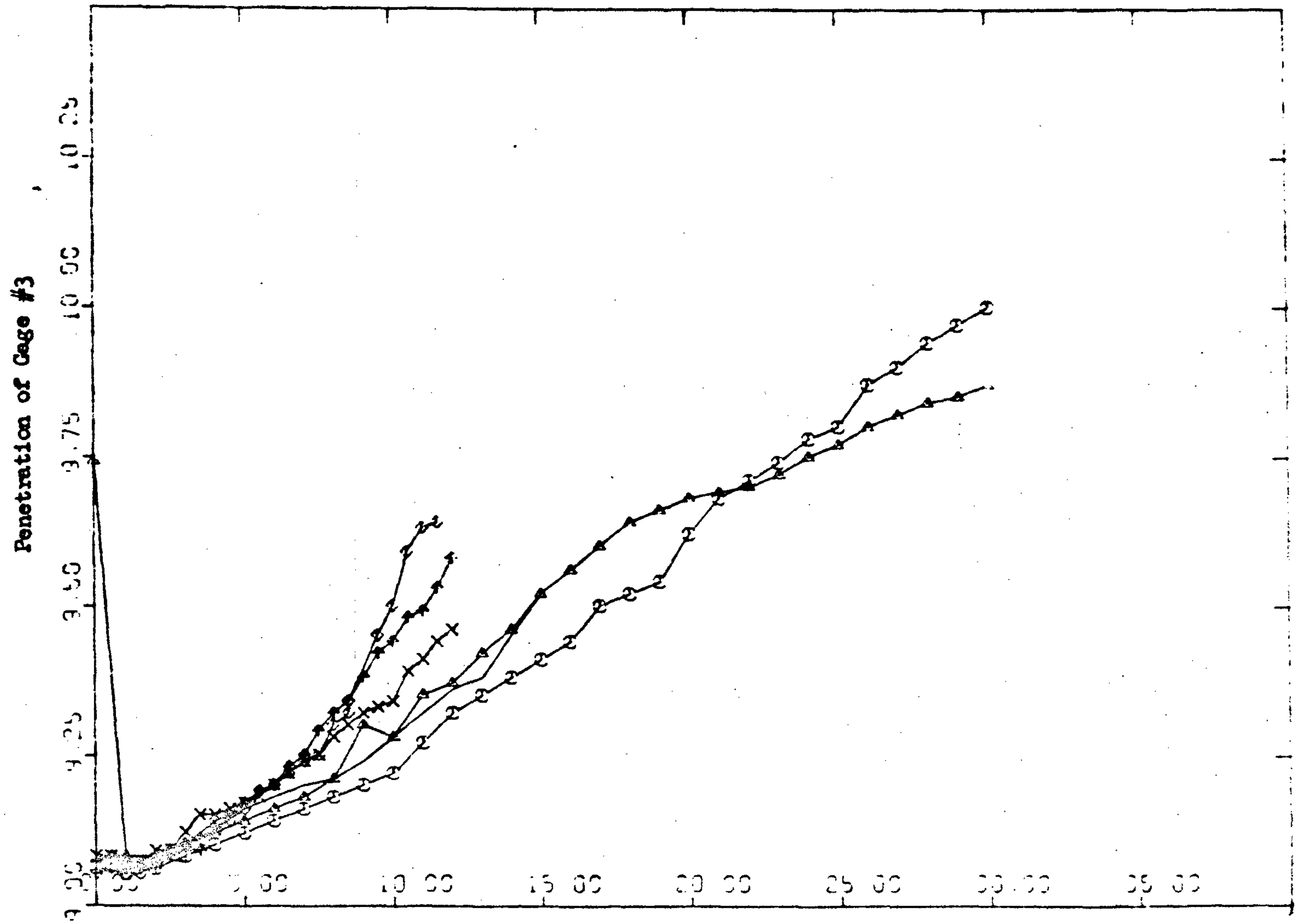


FIGURE 83 - Variation of Penetration for Contractor 'C' Weapons

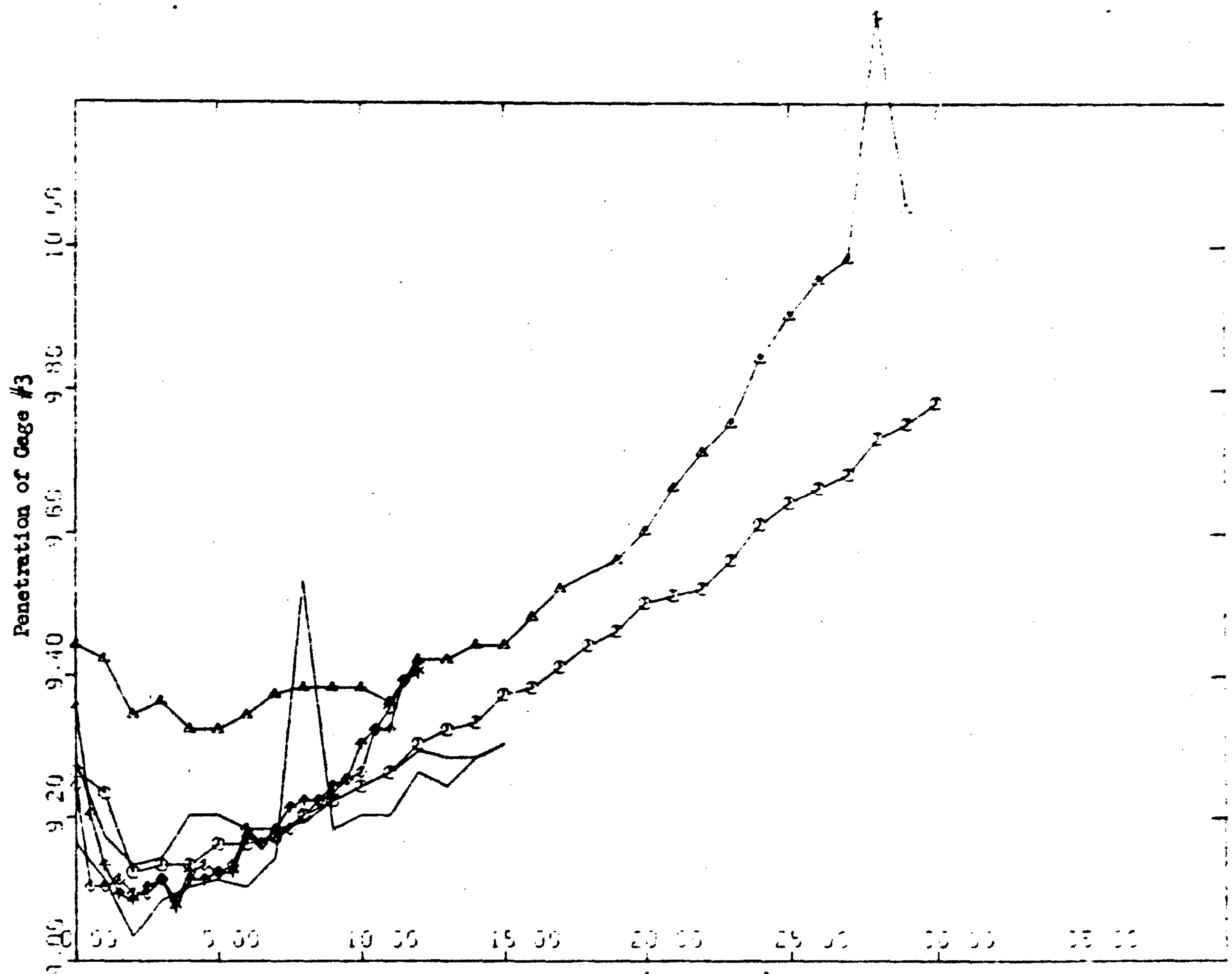


FIGURE 84 - Variation of Penetration for Contractor "GM" Weapons

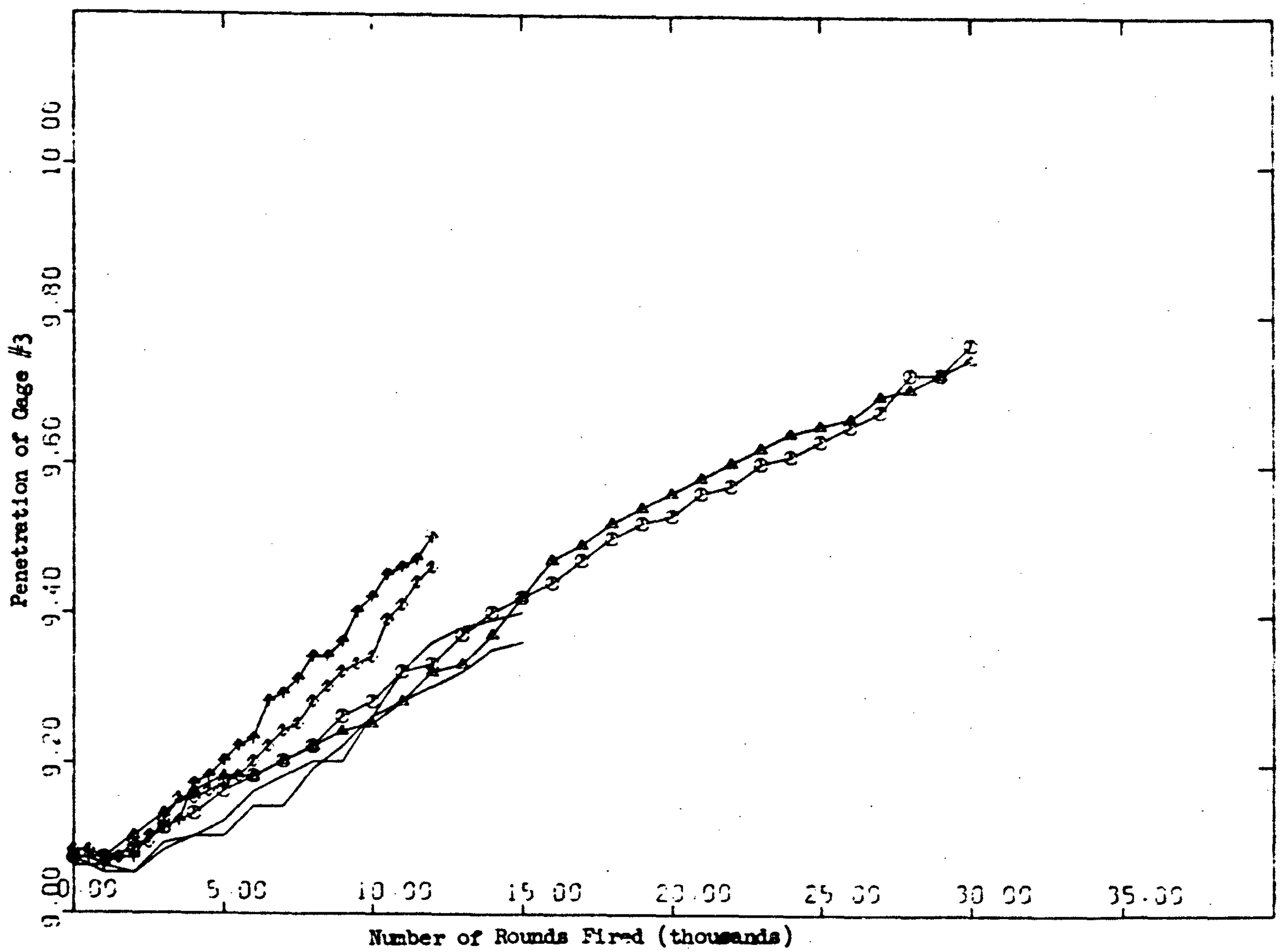


FIGURE 85- Variation of Penetration for Contractor 'M' Weapons

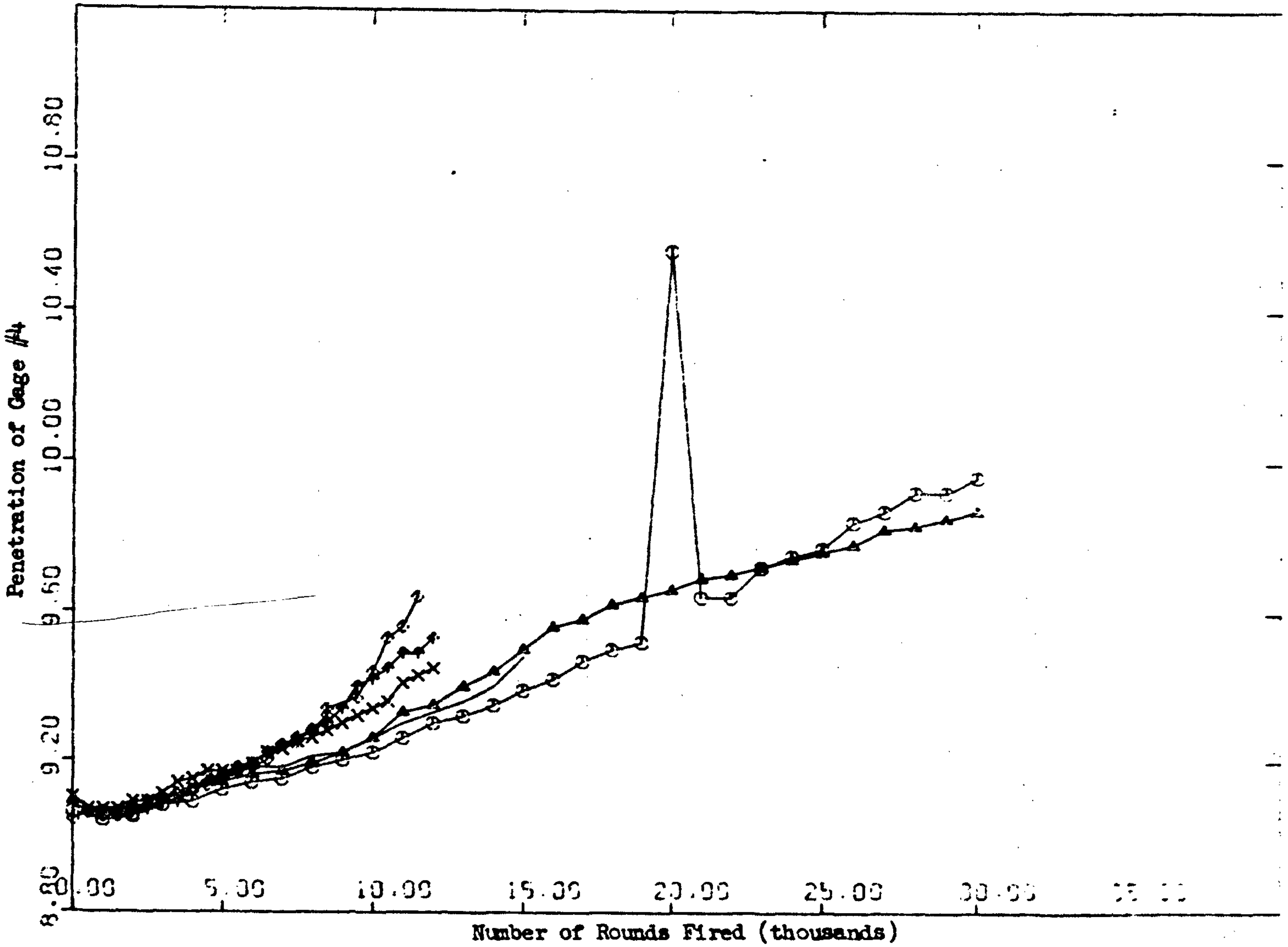


FIGURE 86 - Variation of Penetration for Contractor 'C' Weapons

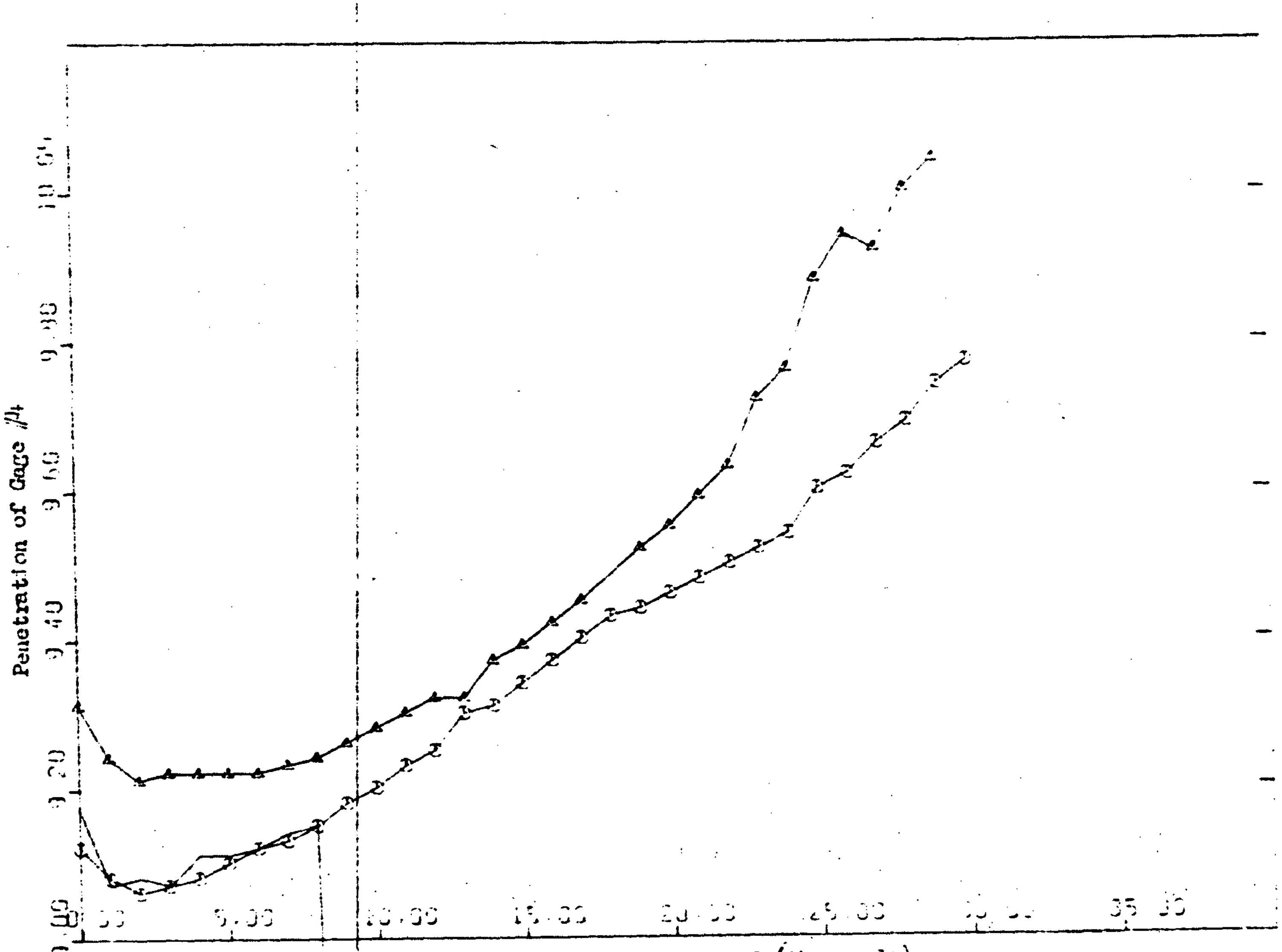


FIGURE 37 - Variation of Penetration for Contractor 'GM' Weapons

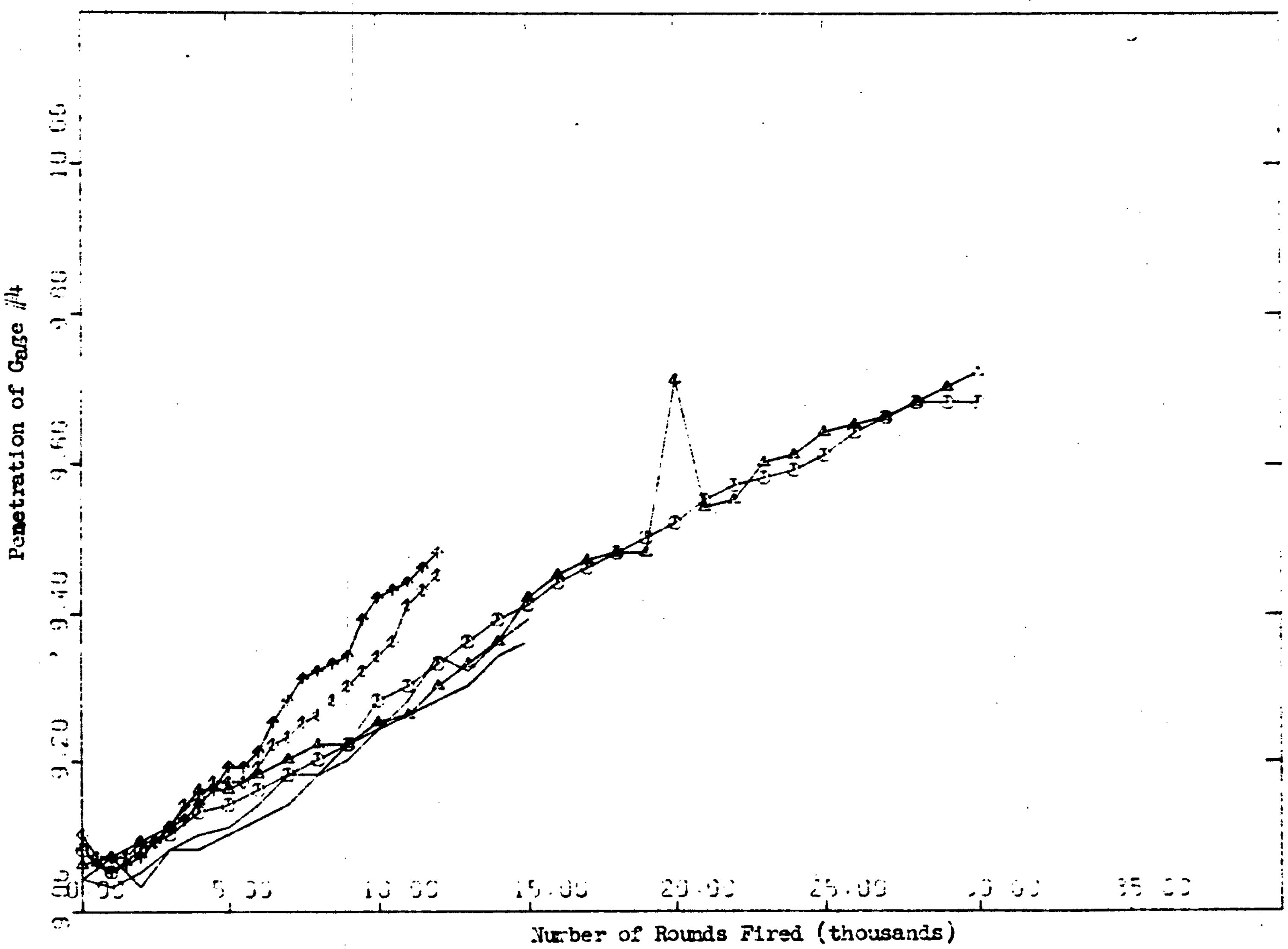


FIGURE 33 - Variation of Penetration for Contractor "M" Weapons

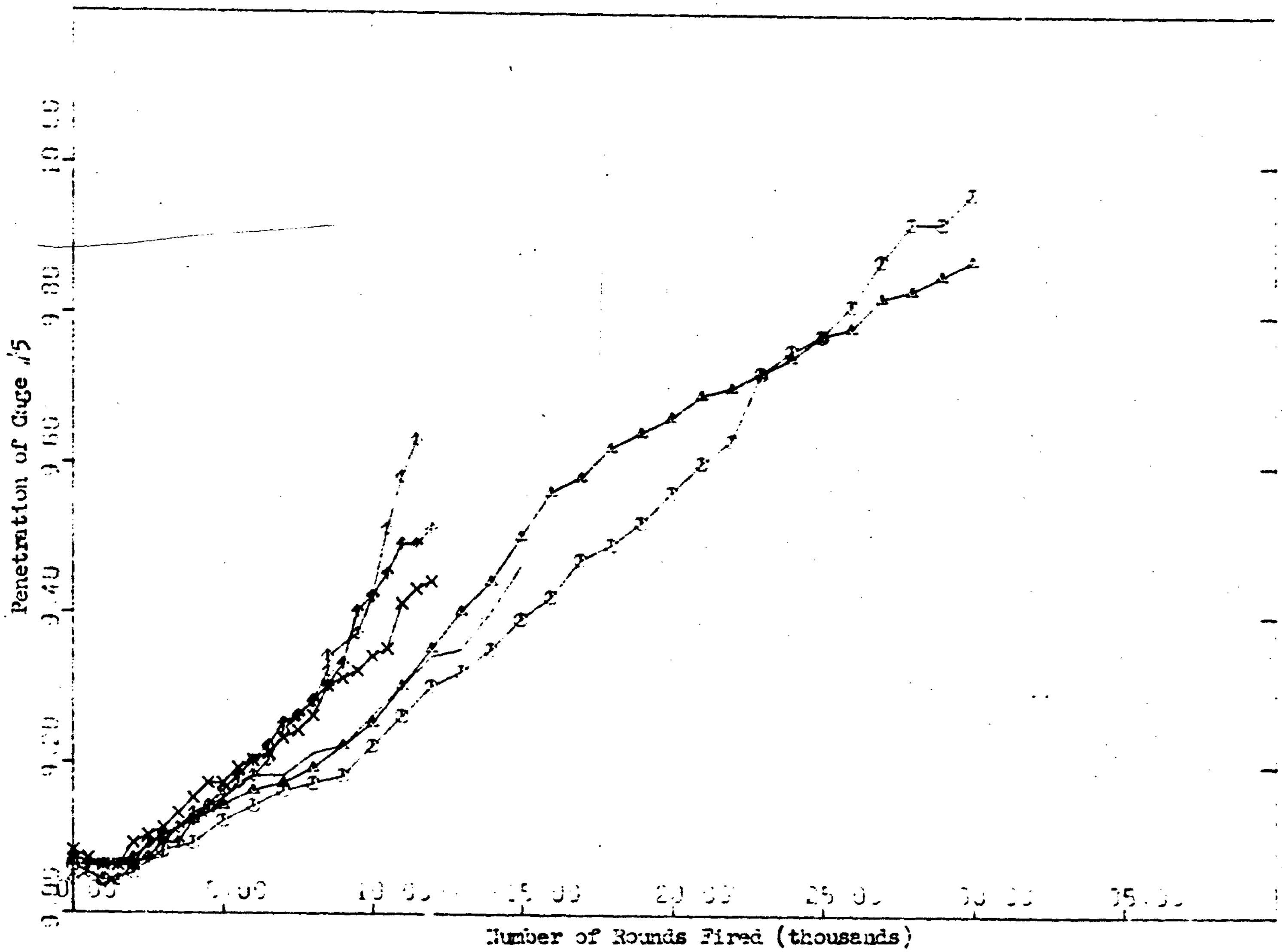


FIGURE 89 - Variation of Penetration for Contractor 'C' Weapons

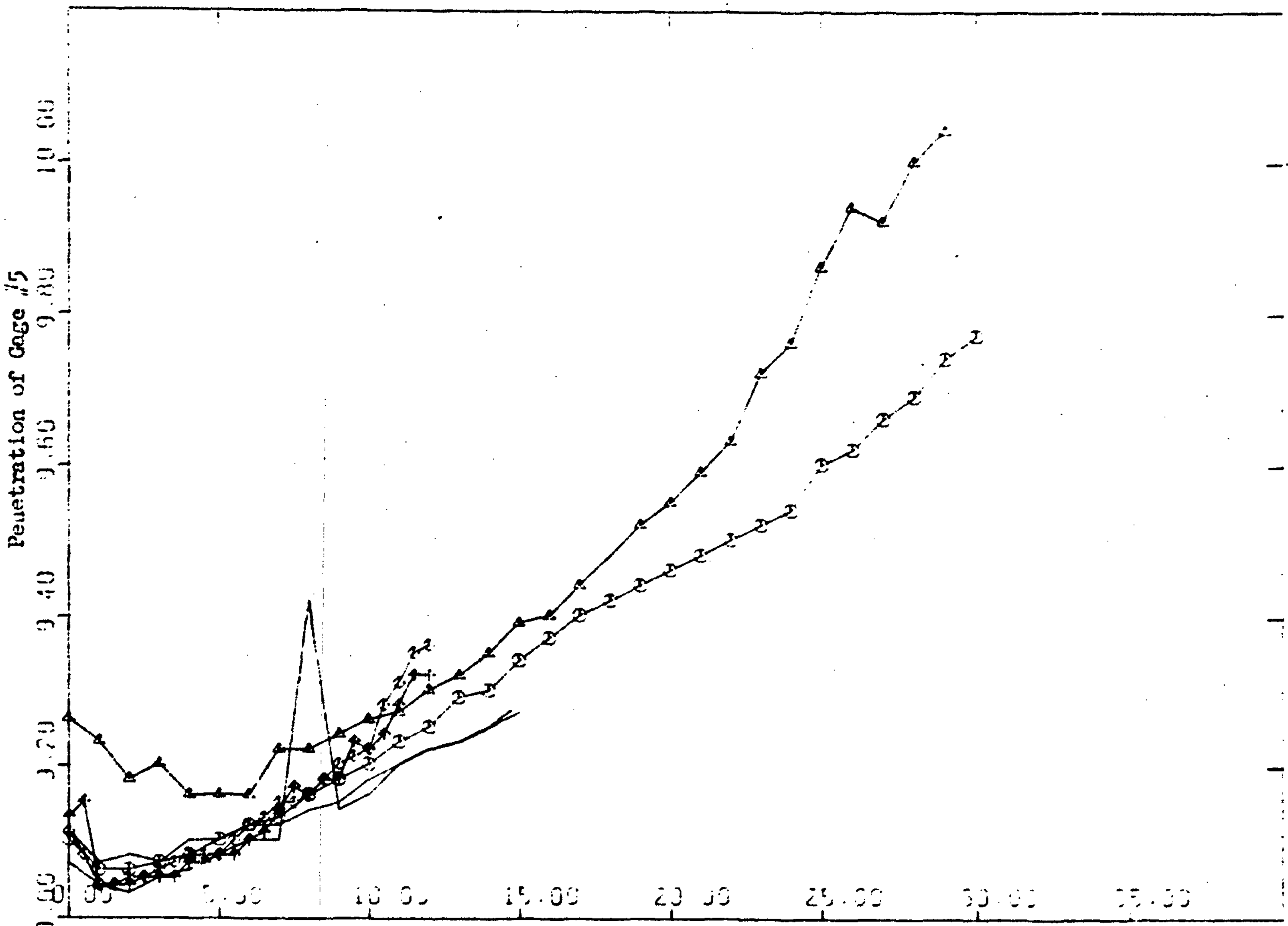


FIGURE 90 - Variation of Penetration for Contractor 'GM' Weapons

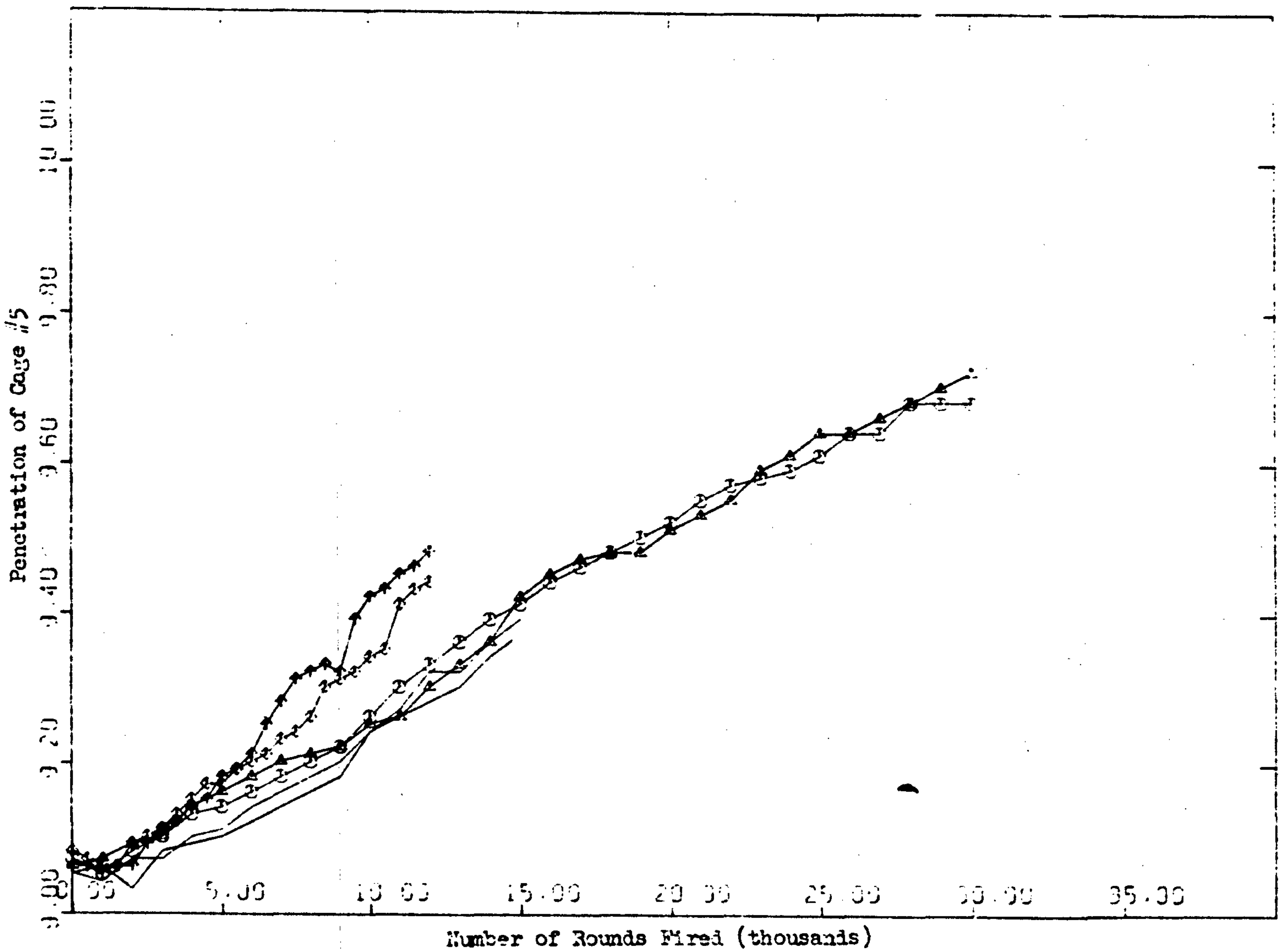


FIGURE 91 - Variation of Penetration for Contractor 'M' Weapons

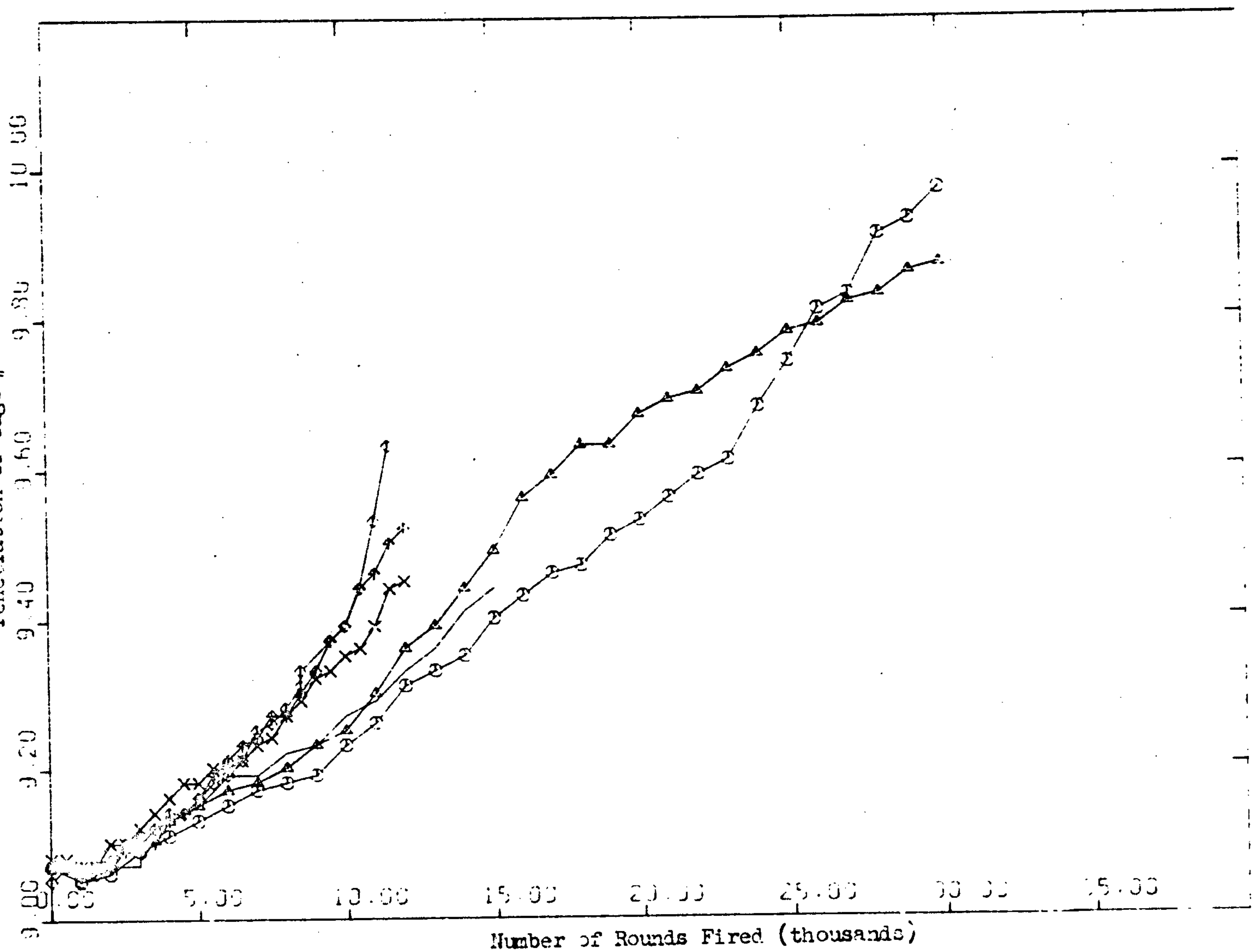


FIGURE 92 - Variations of Penetration for Contractor 'C' Weapons

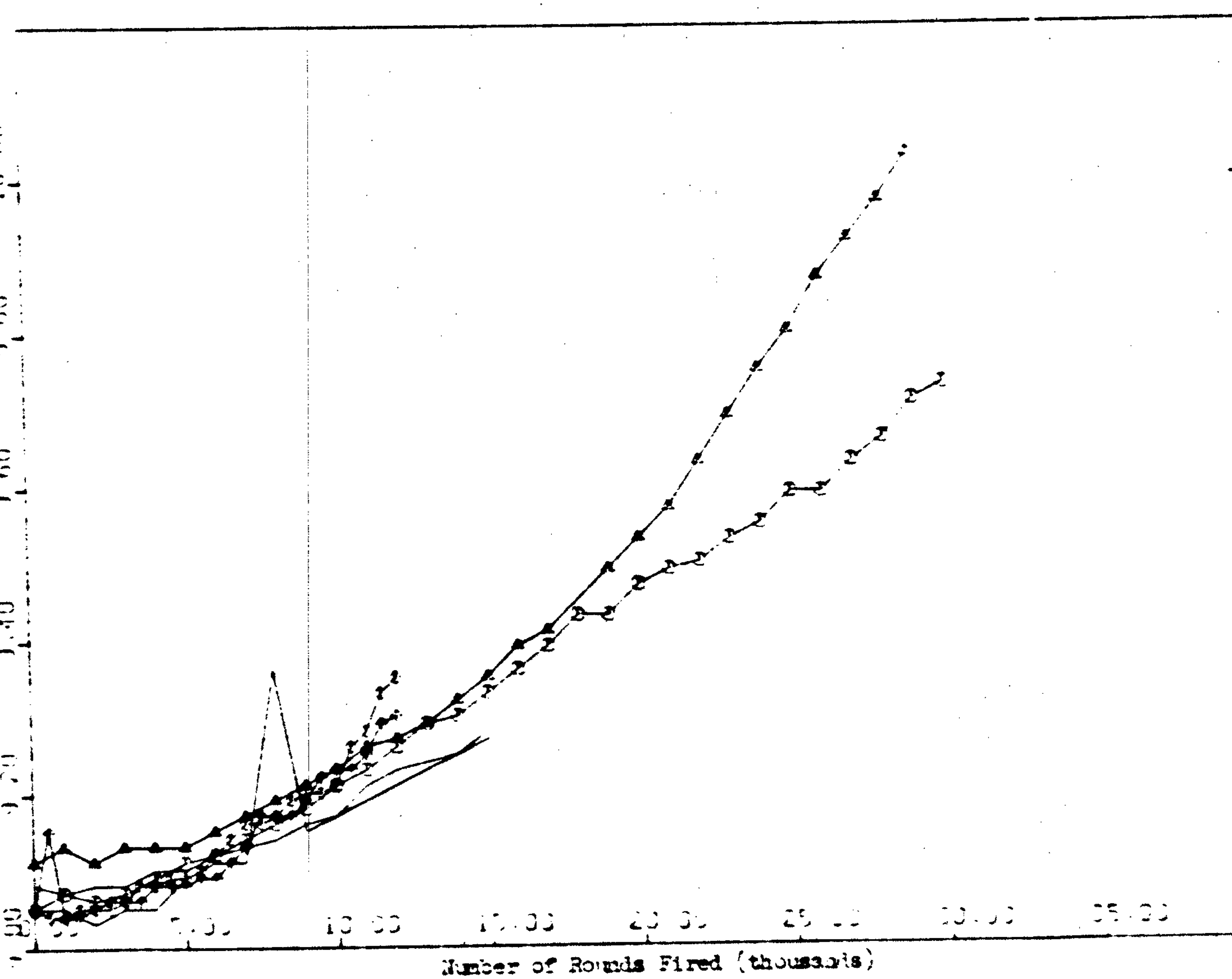


FIGURE - 33 - Variation of Penetration order to Contractor 'H' Weapons

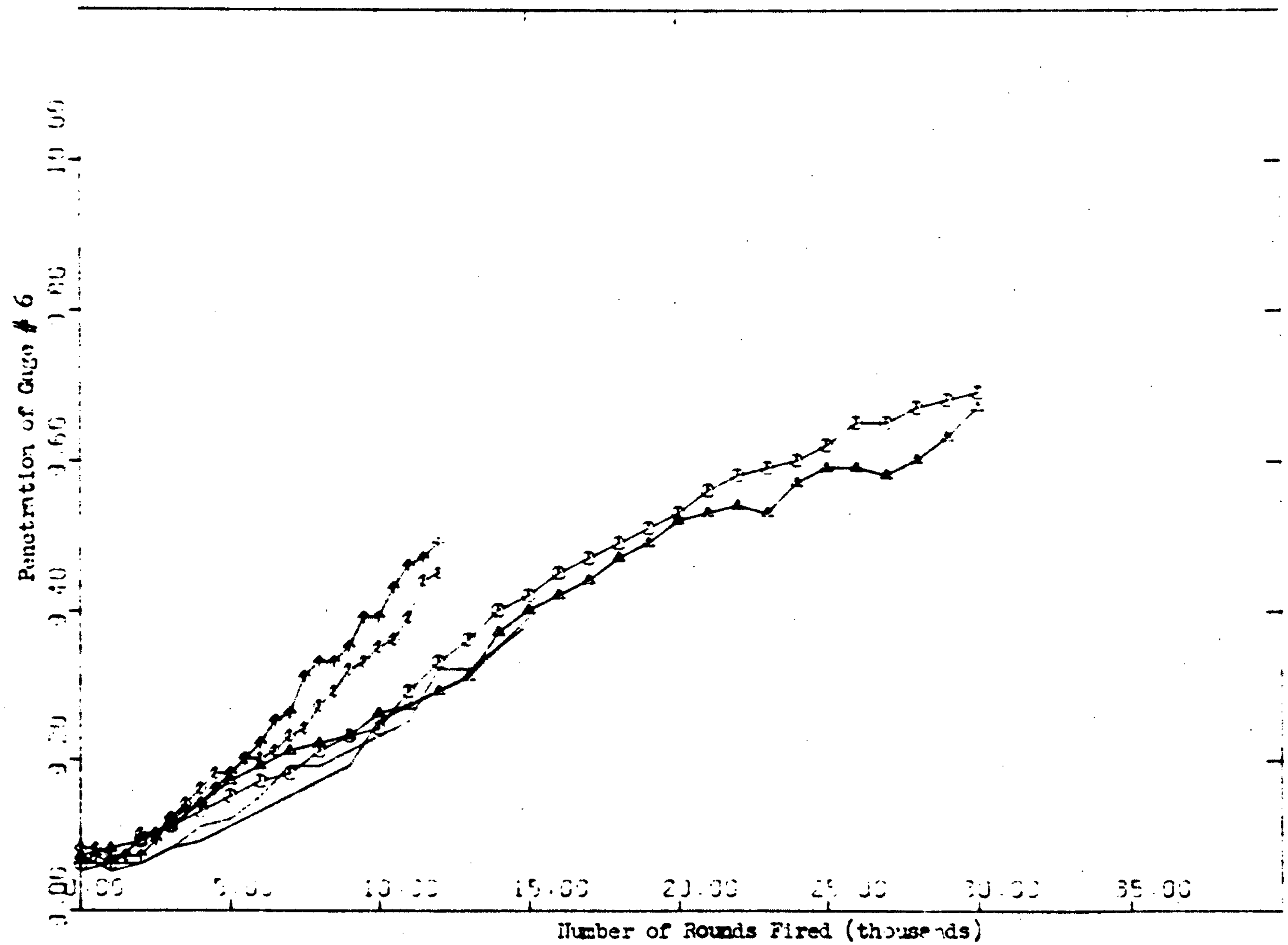


FIGURE 34 - Variation of Penetration order to Contractor 'M' Weapons

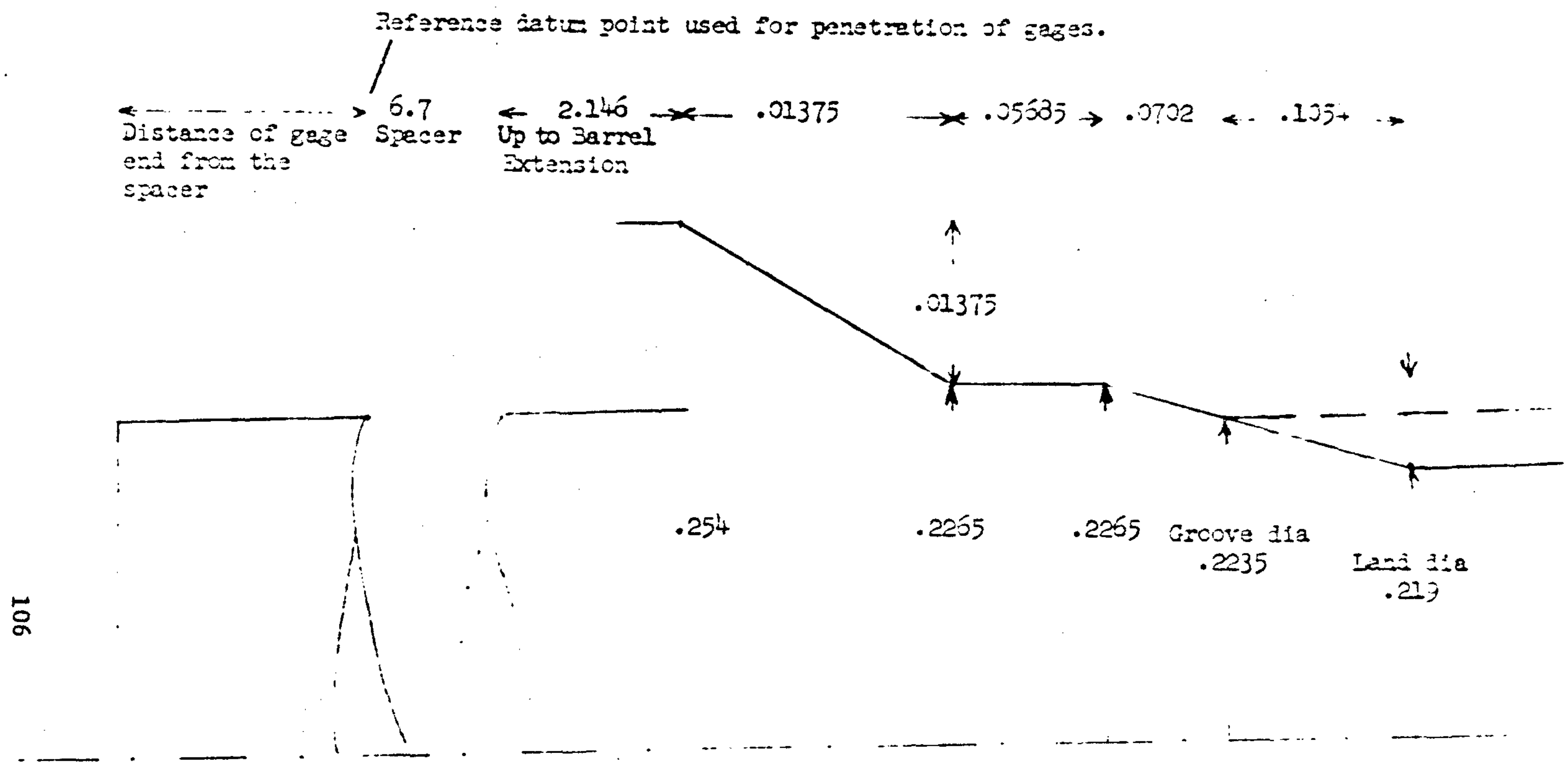


FIGURE 95 BORE SURFACE AT THE ORIGIN OF RIFLING

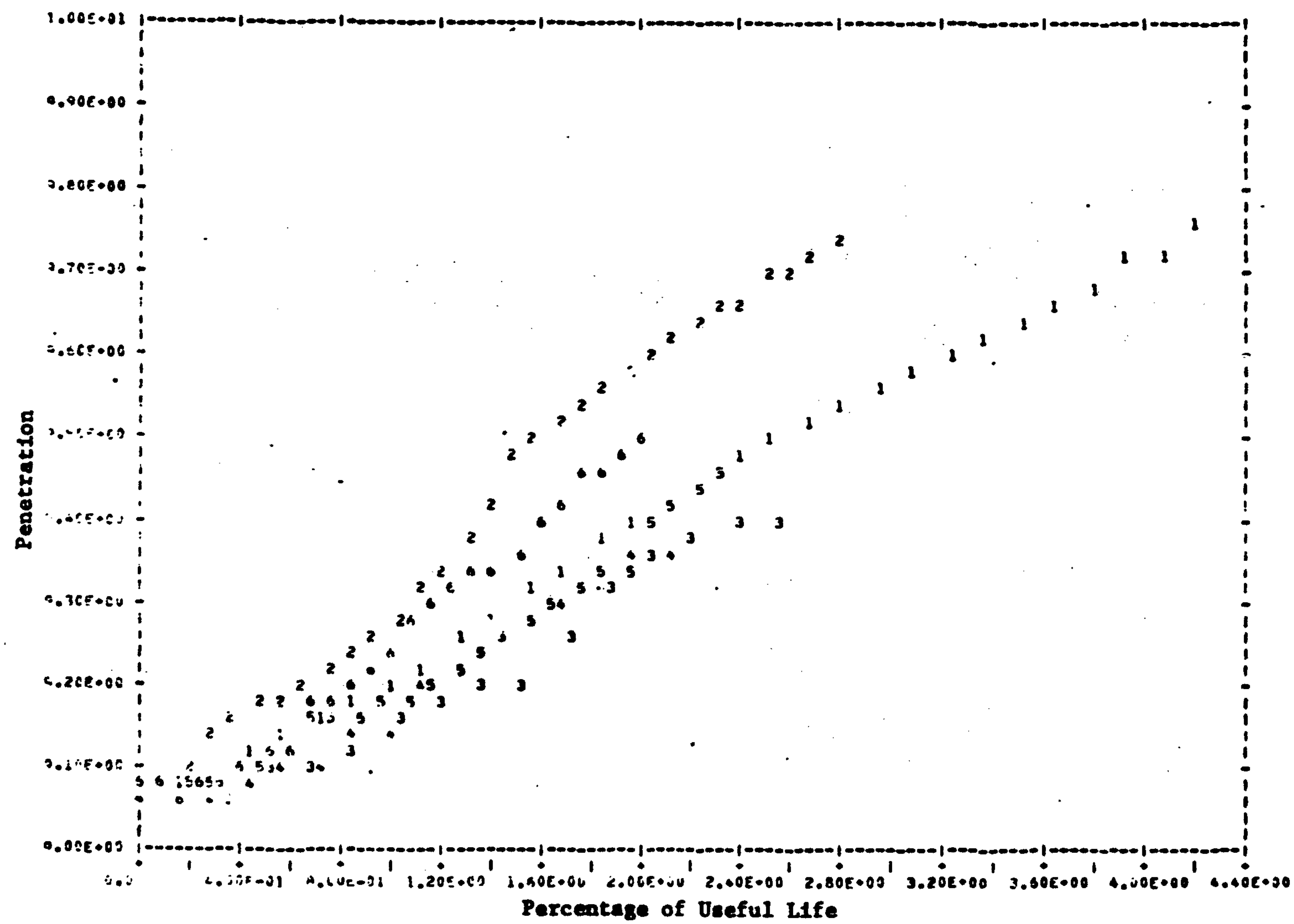


Figure 96 - Penetration of Gage 3 in M-Series Barrels

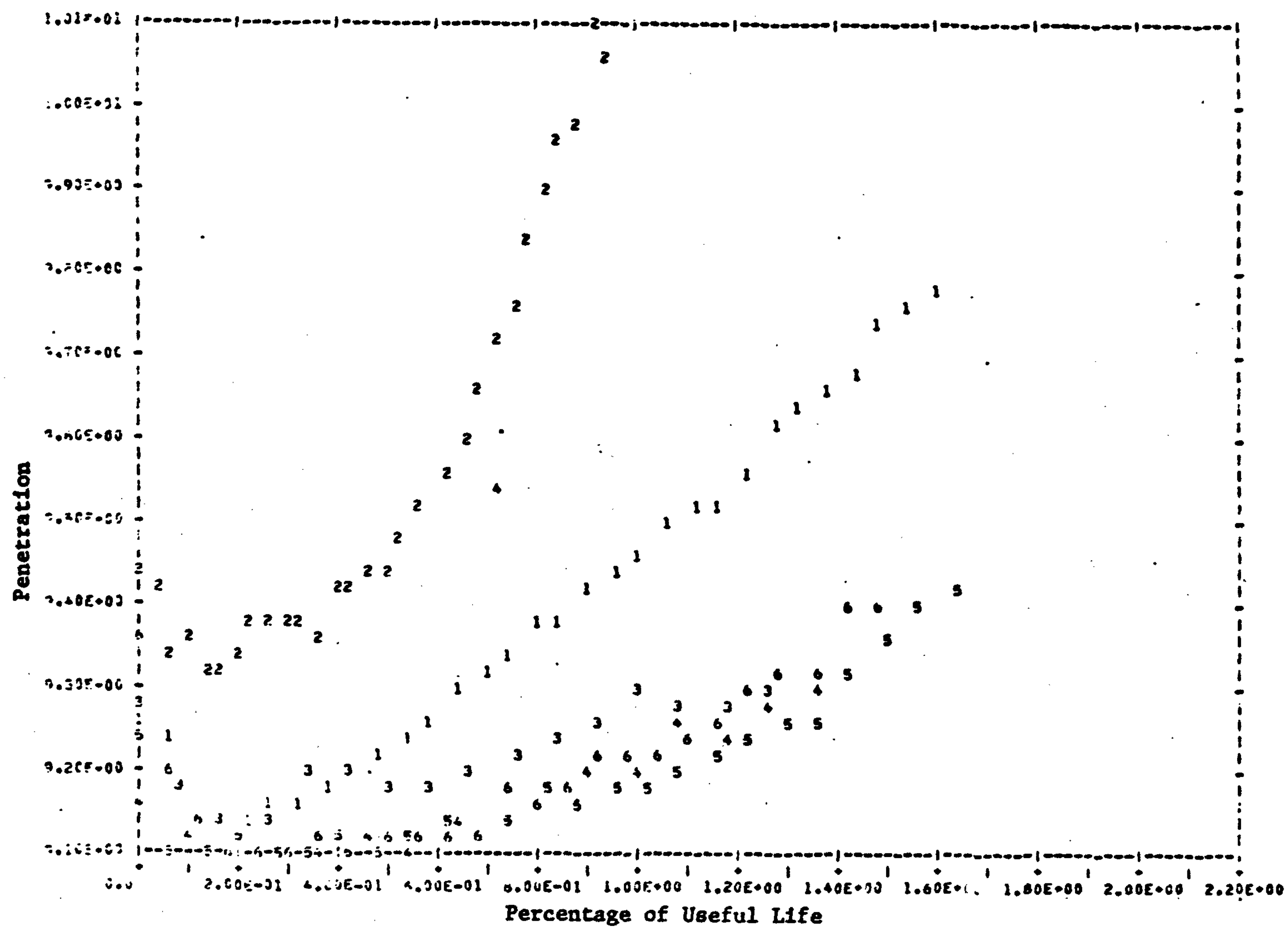


Figure 97 - Penetration of Gage 3 in GM-Series Barrels

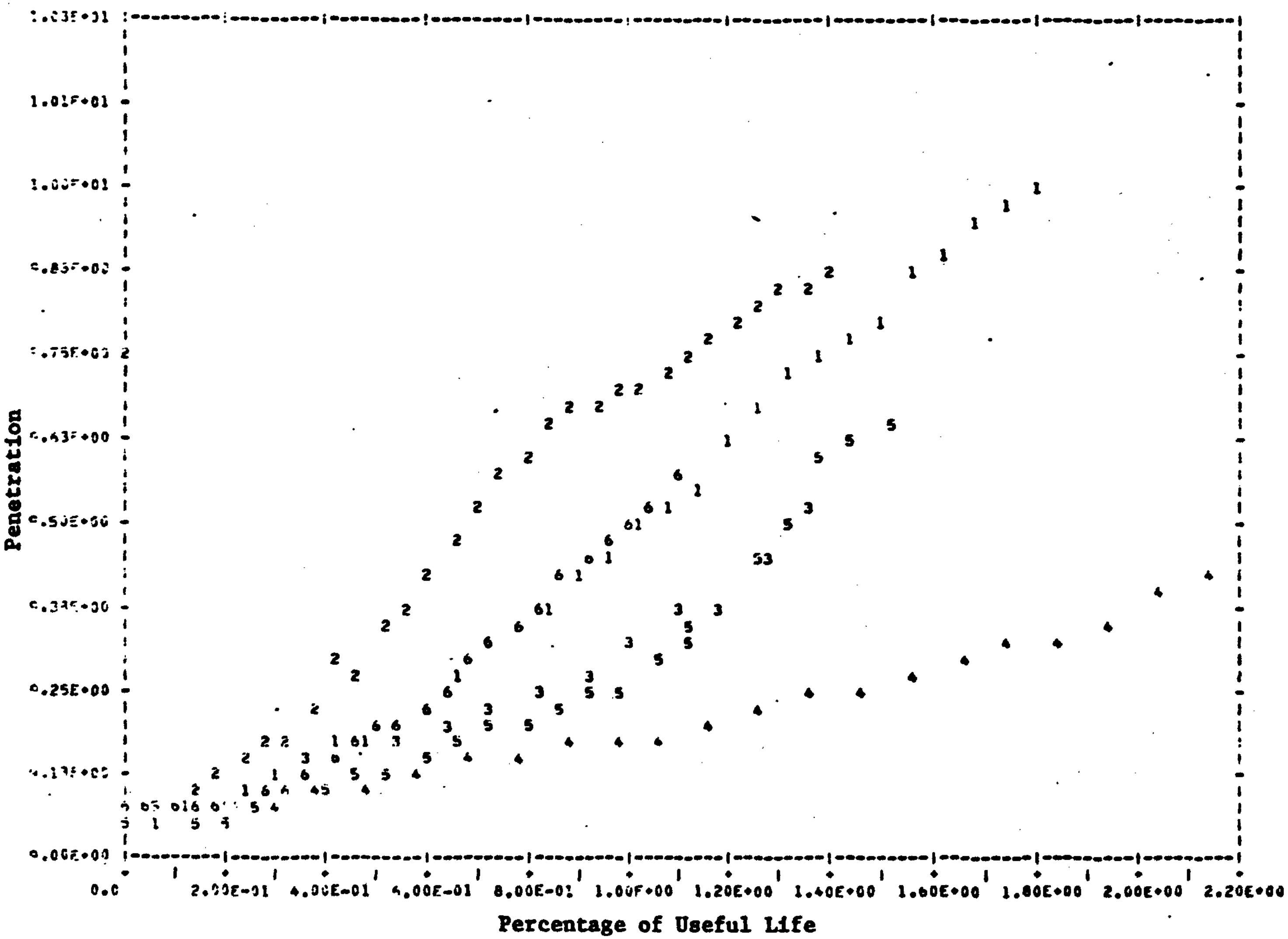


Figure 98 - Penetration of Gage 3 in C-Series Barrels

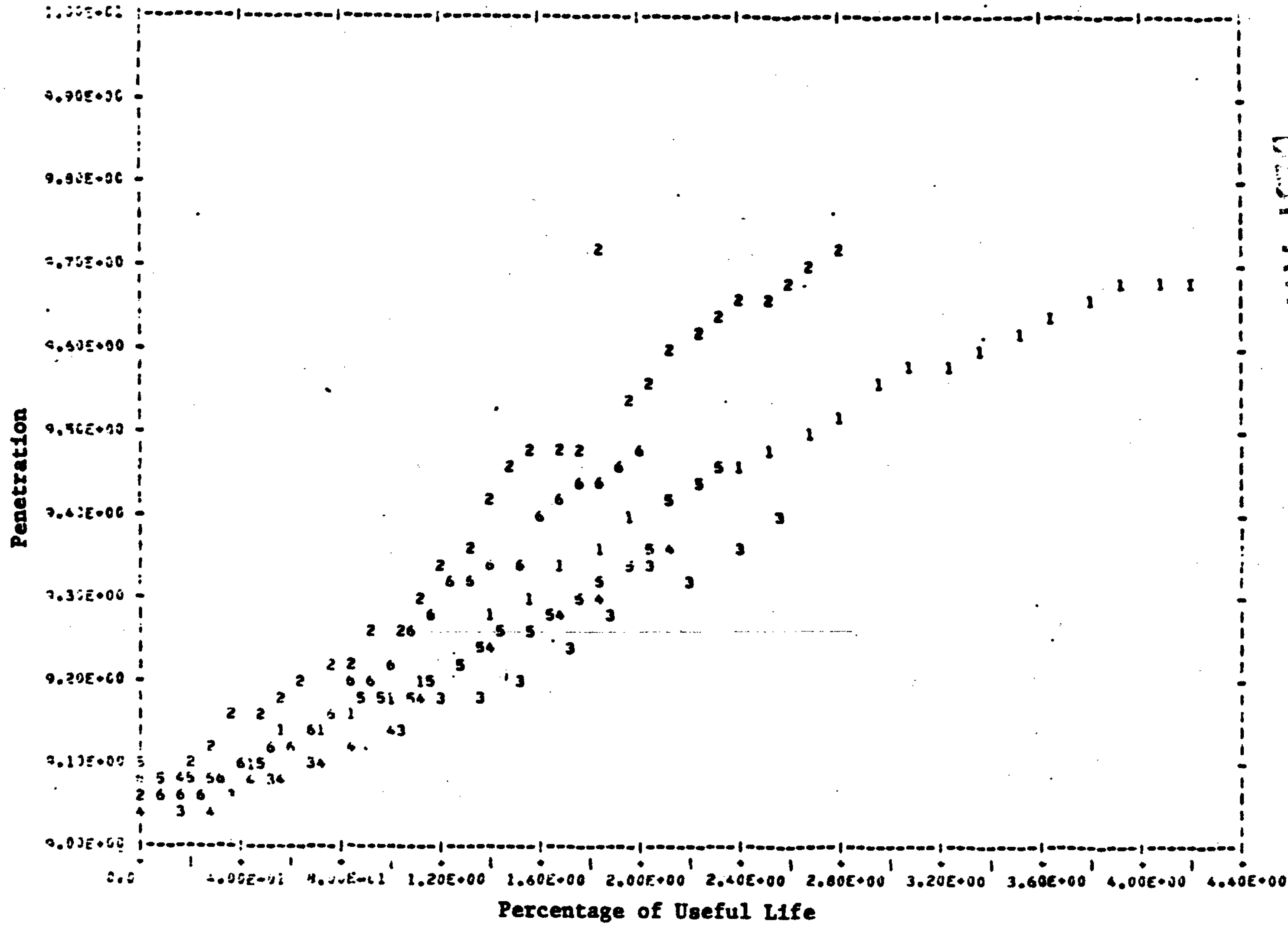


Figure 99 - Penetration of Gage 4 in M-Series Barrels

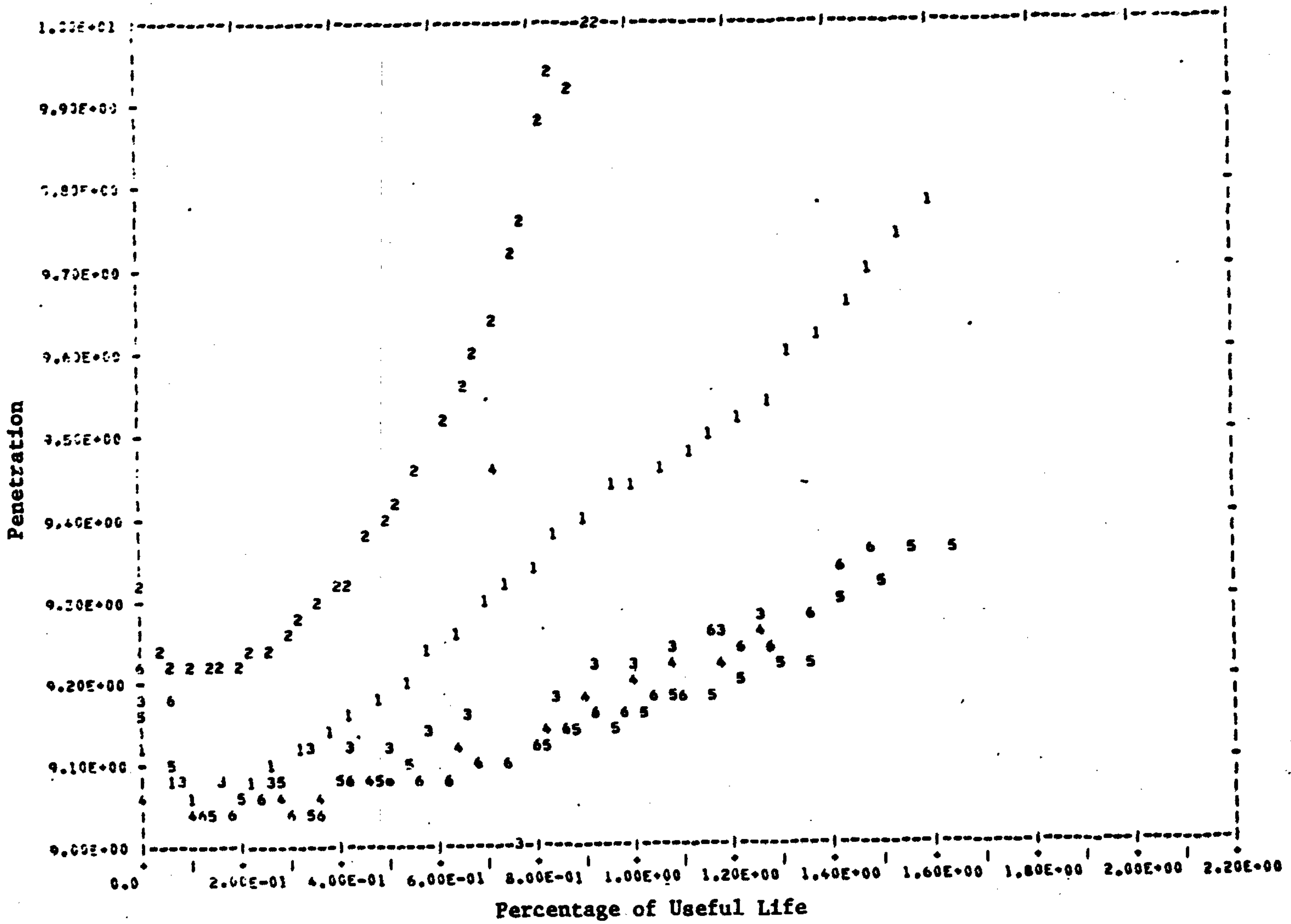


Figure 100 - Penetration of Gage 4 in GM-Series Barrels

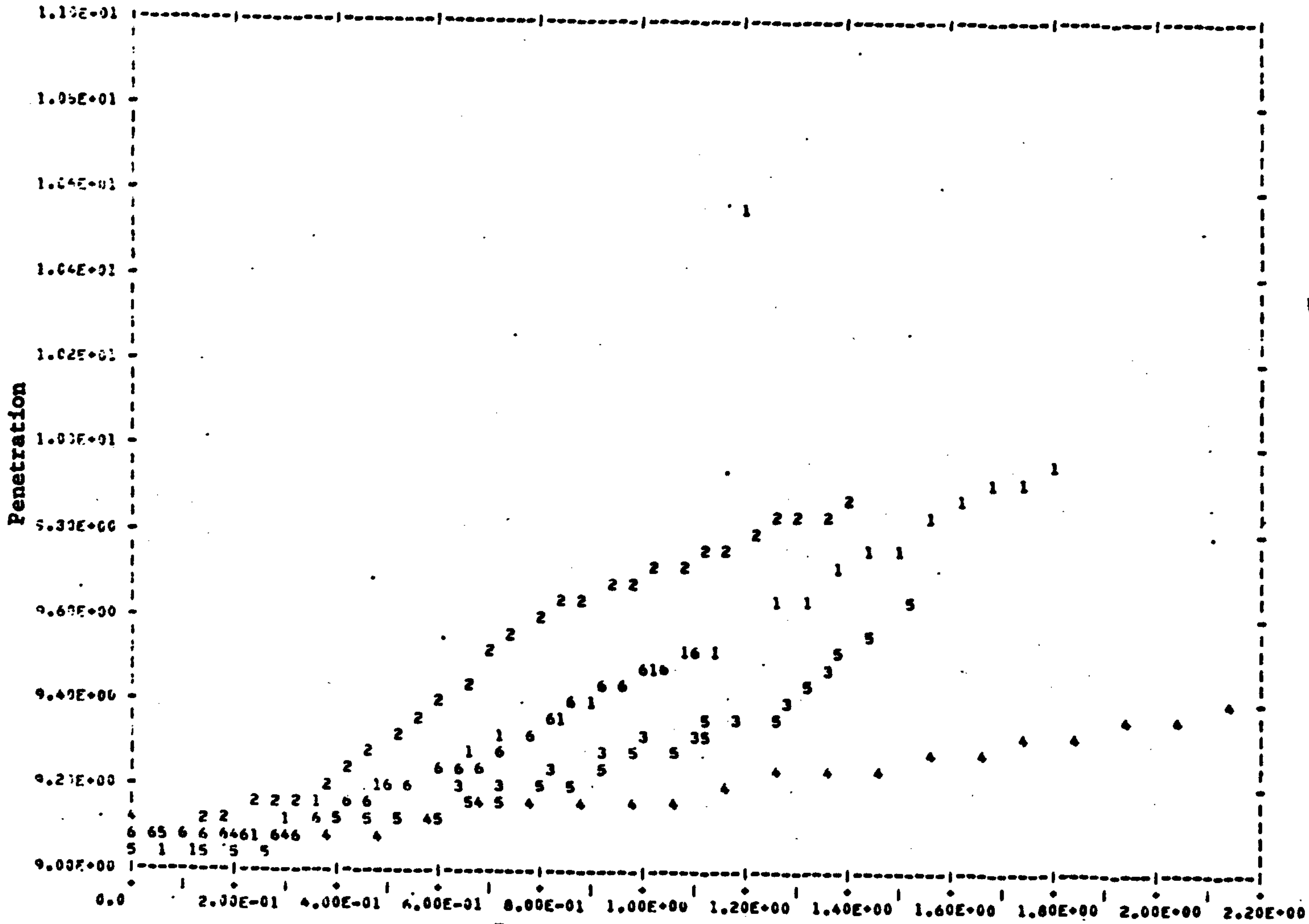


Figure 101 - Penetration of Gage 4 in C-Series Barrels

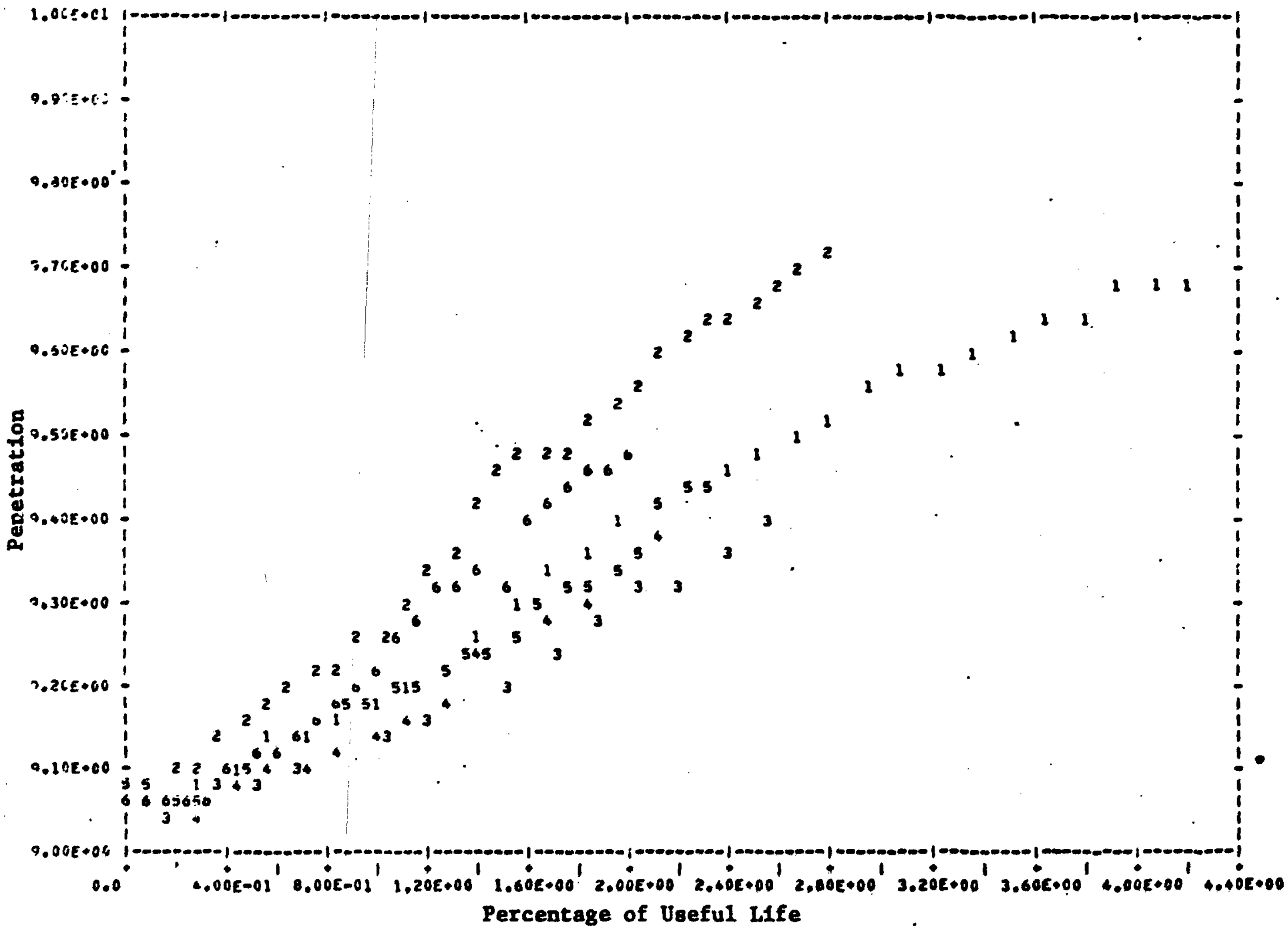


Figure 102 - Penetration of Gage 5 in M-Series Barrels

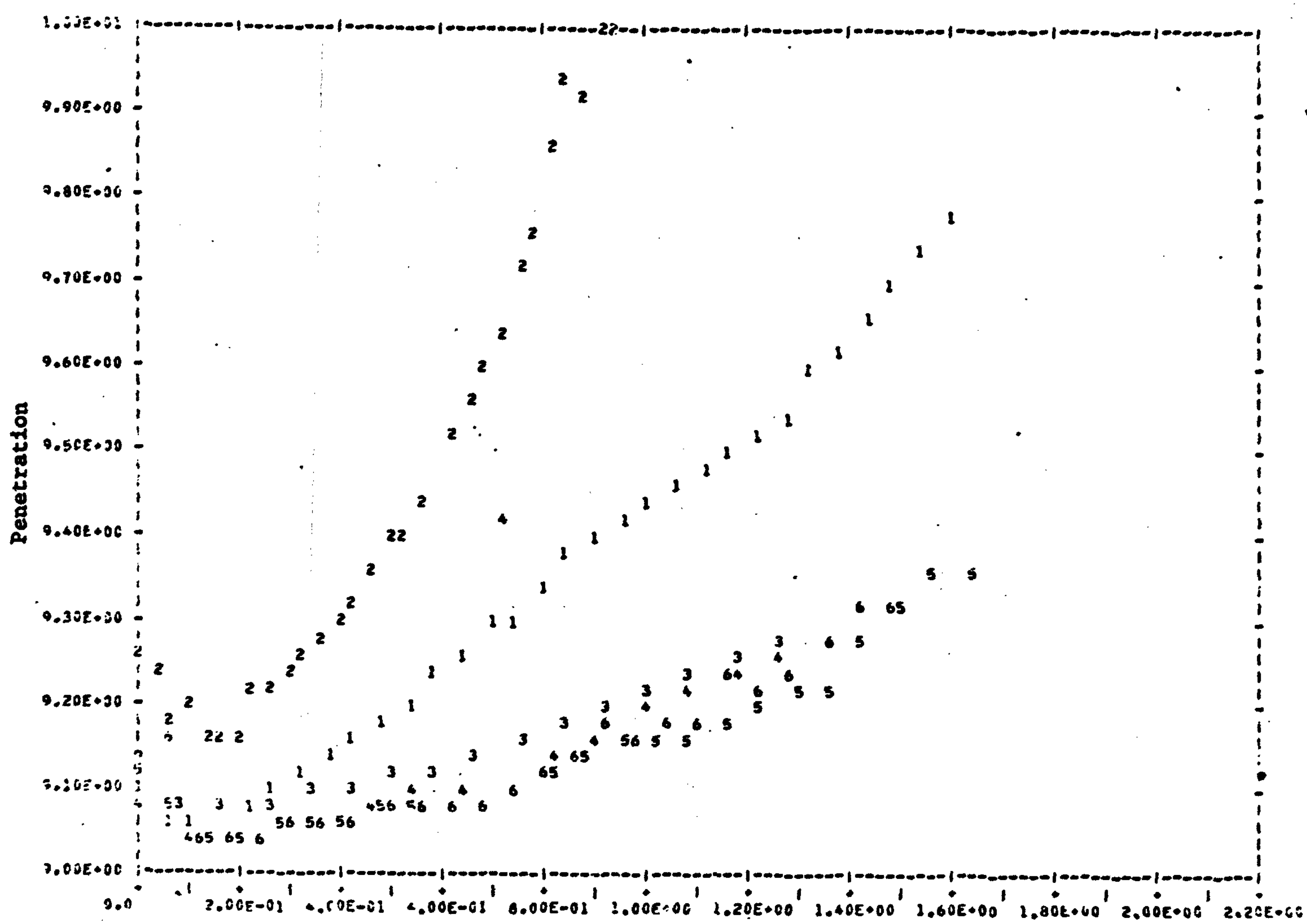


Figure 103 - Penetration of Gage 5 in GM-Series Barrels

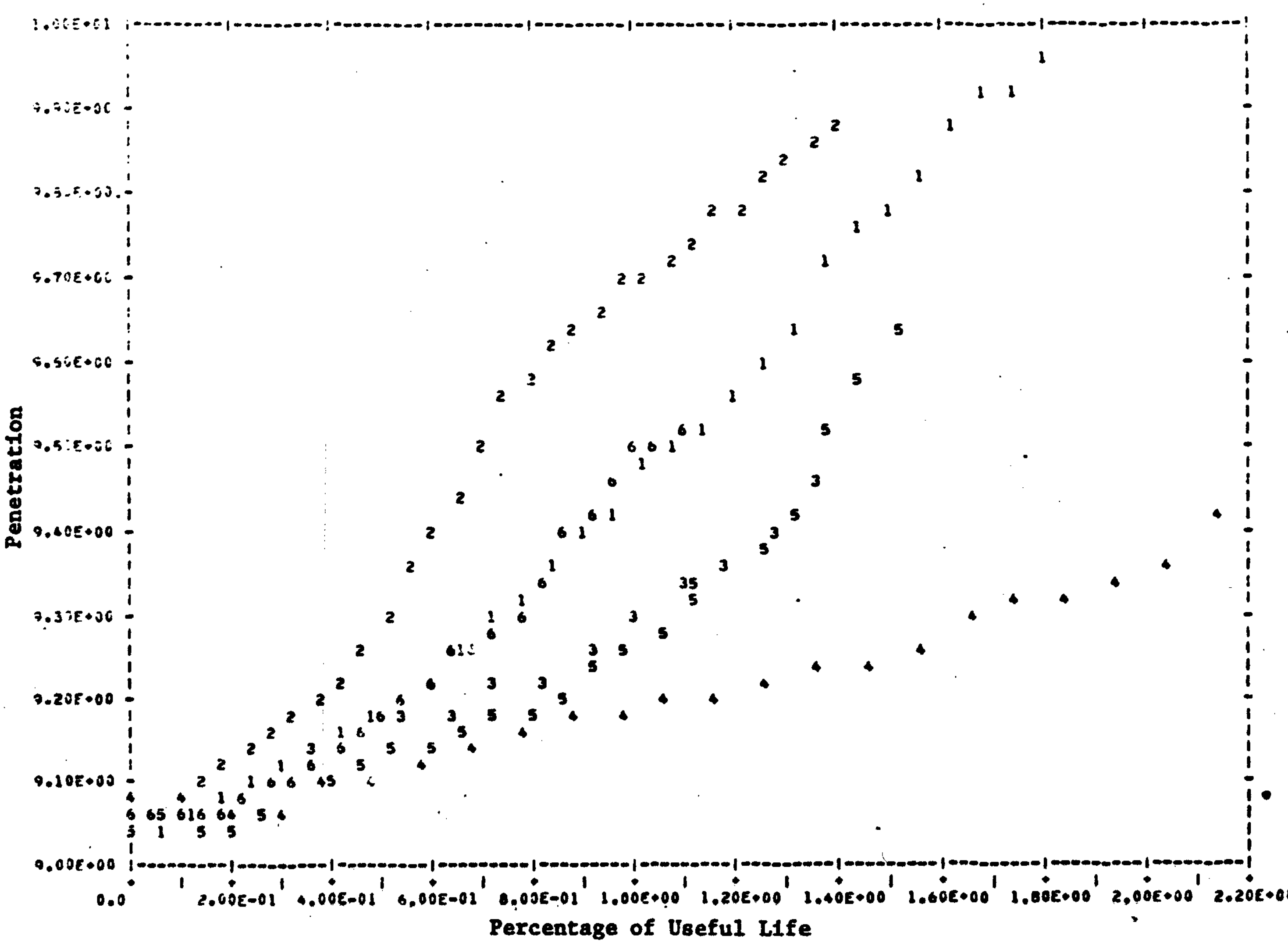


Figure 104 - Penetration of Gage 5 in C-Series Barrels

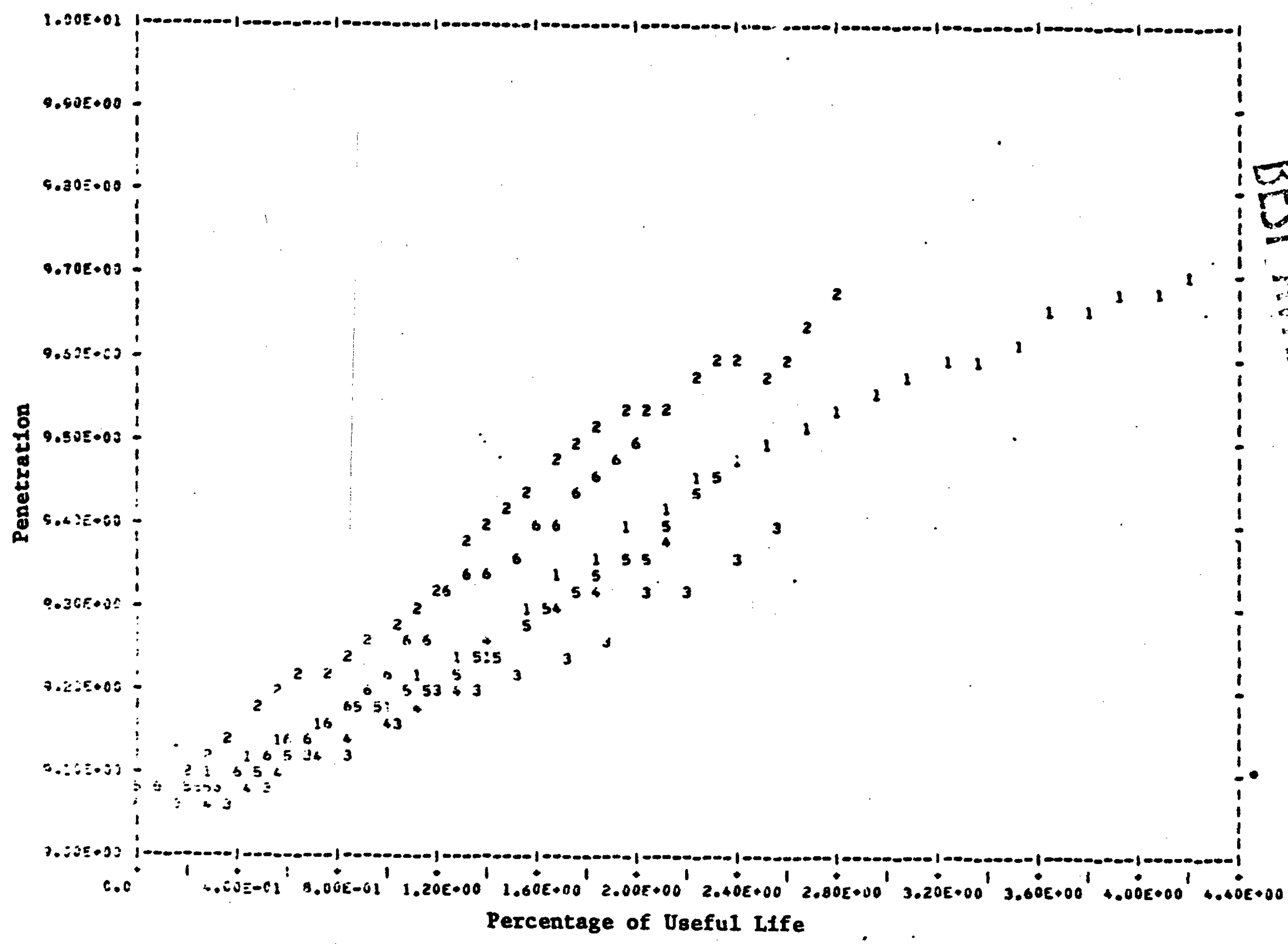


Figure 105 - Penetration of Gage 6 in M-Series Barrels

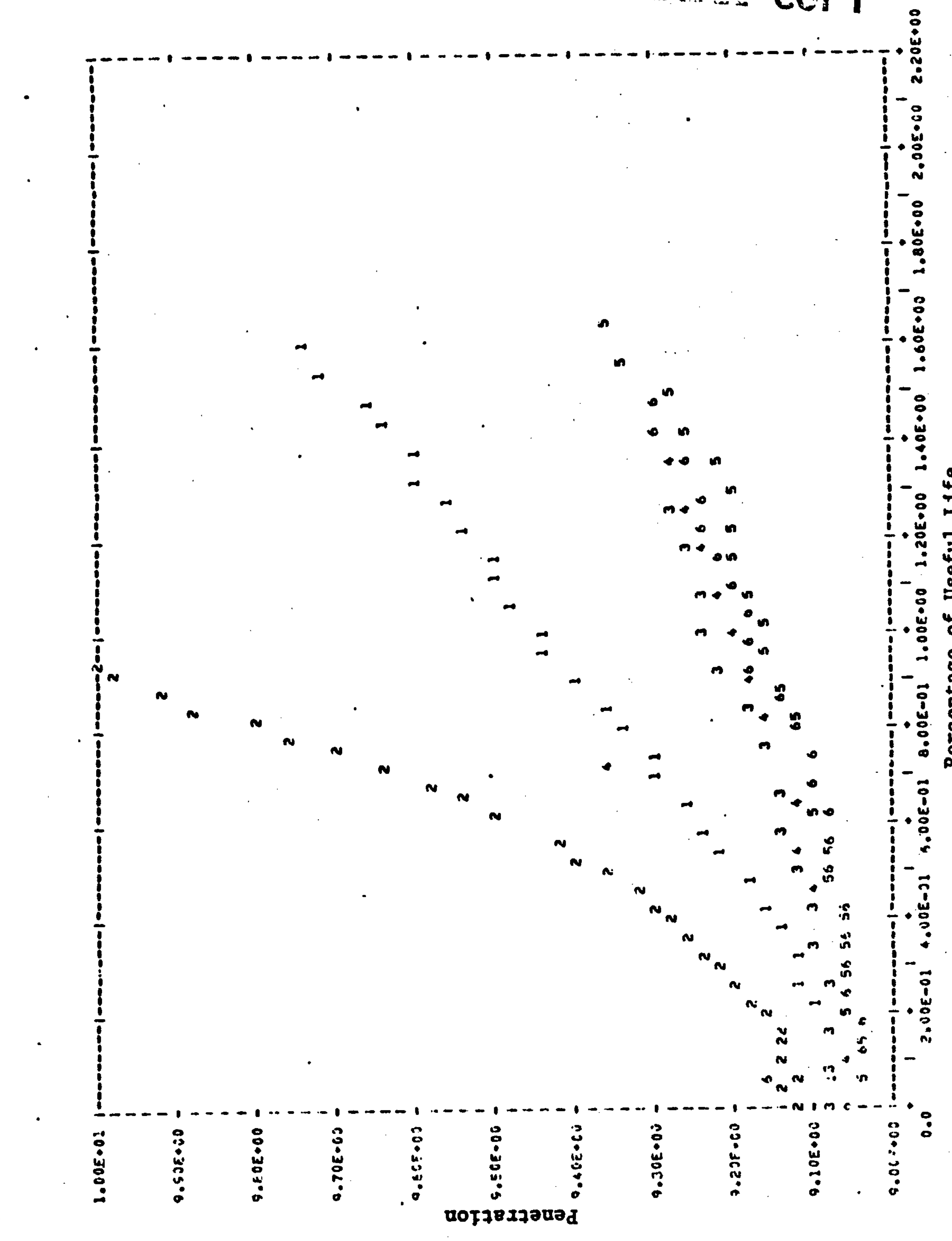


Figure 106 - Penetration of Gage 6 in GM-Series Barrels

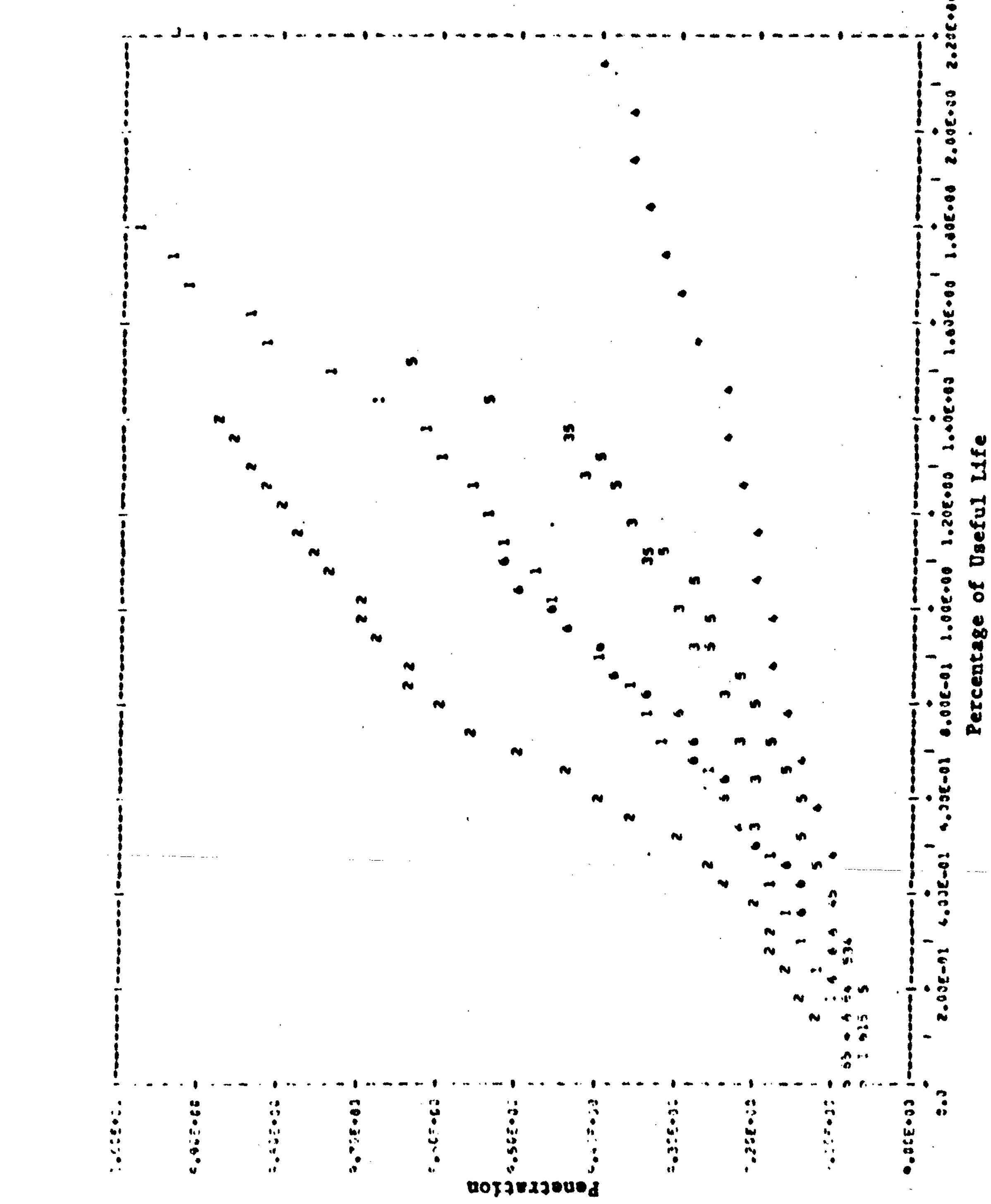


Figure 107 - Penetration of Gage 6 in C-Series Barrels

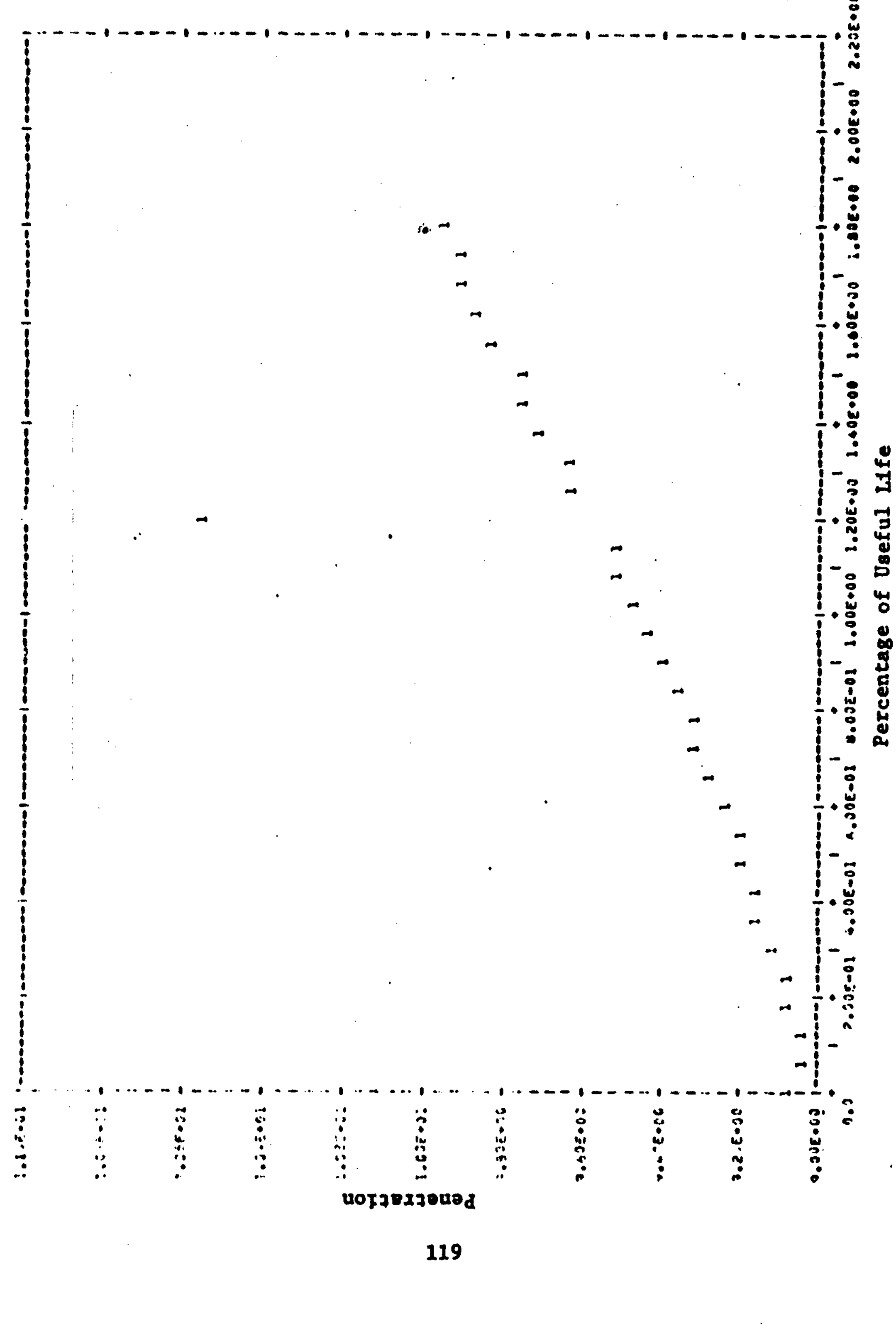


Figure 108 - Penetration of Gage 4 in C1

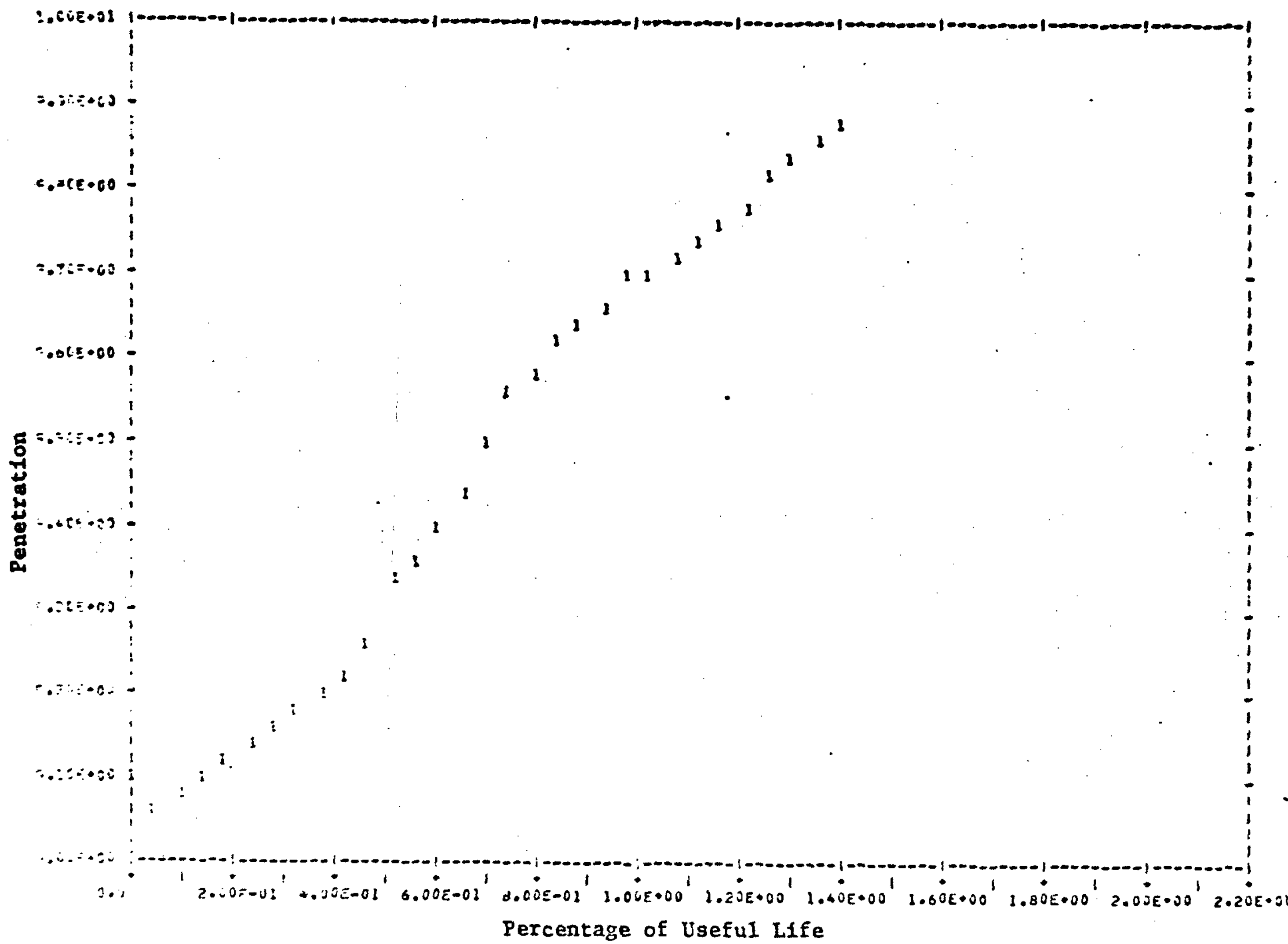


Figure 109 - Penetration of Gage 4 in C2

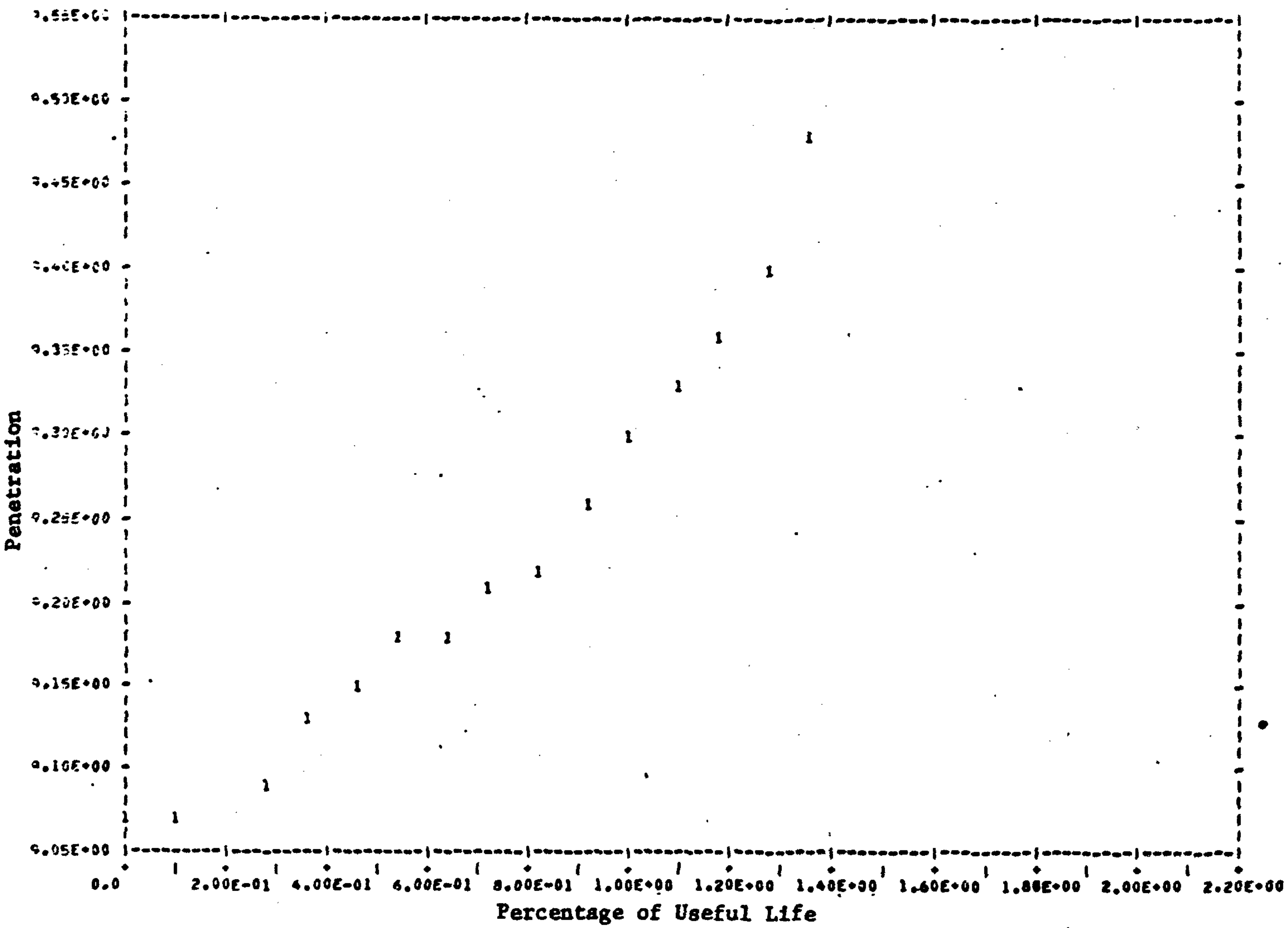


Figure 110 - Penetration of Gage 4 in C4

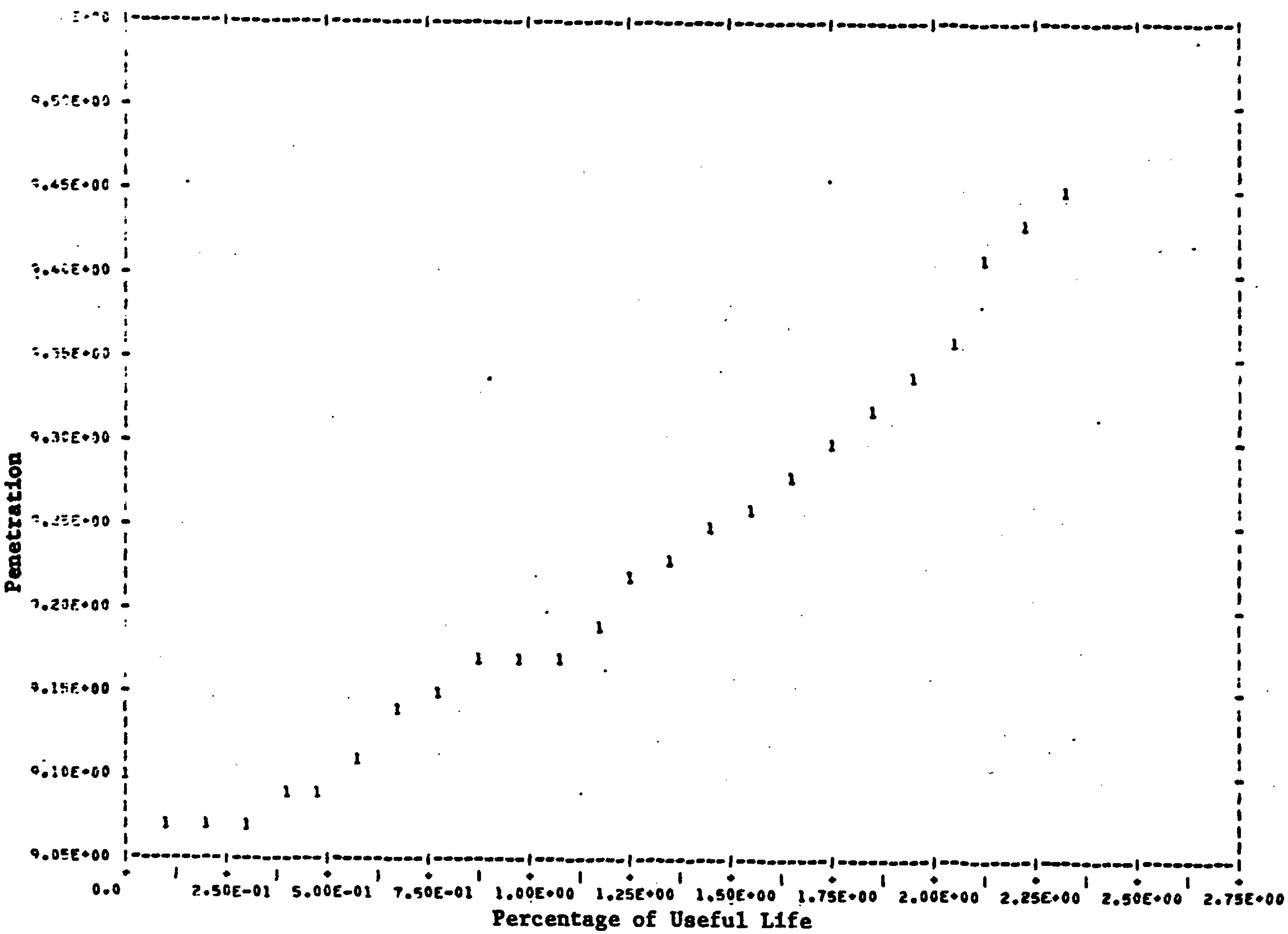


Figure 111 - Penetration of Gage 4 in C5

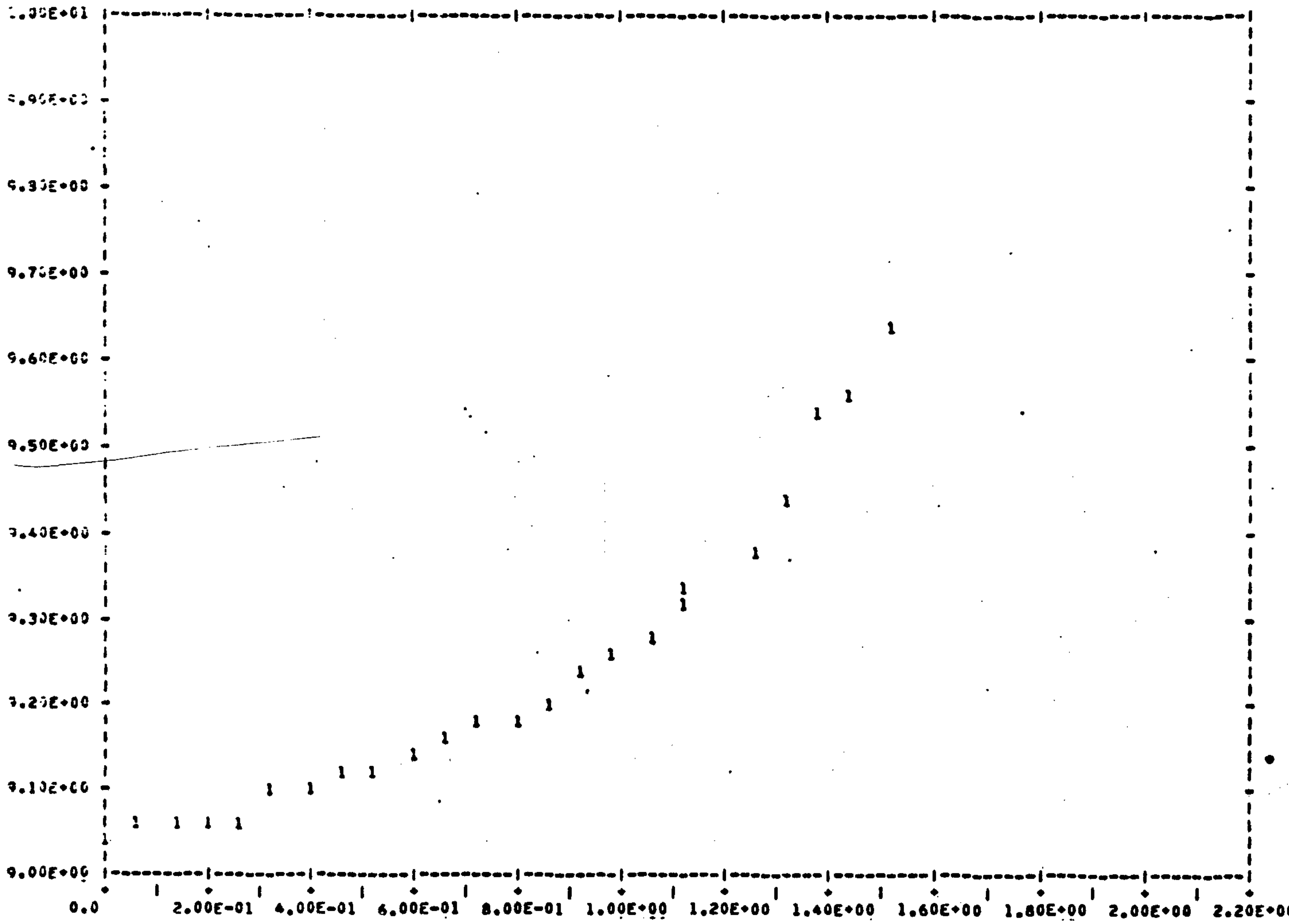


Figure 112 - Penetration of Gage 4 in C7

BEST AVAILABLE COPY

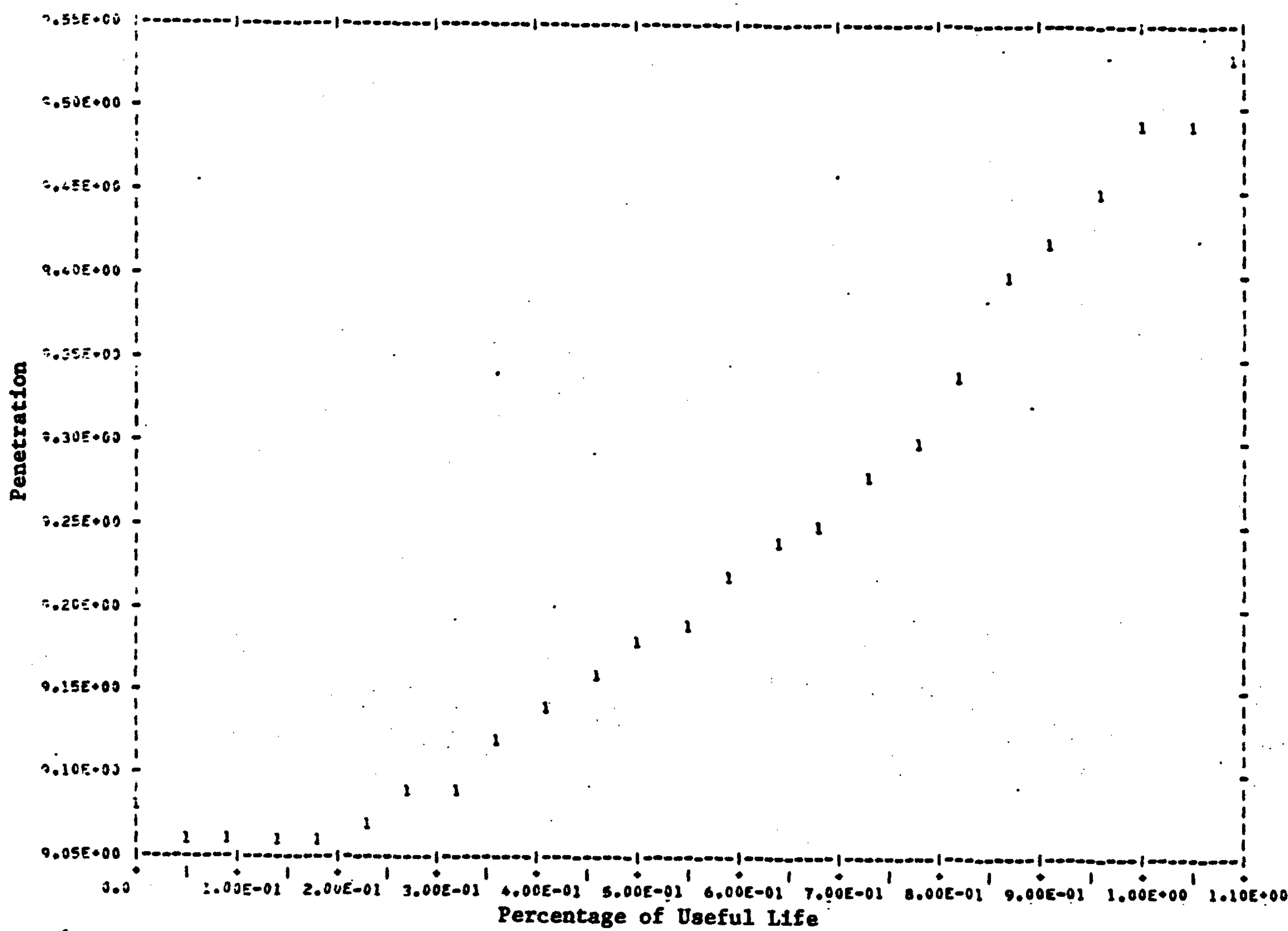


Figure 113 - Penetration of Gage 4 in C8

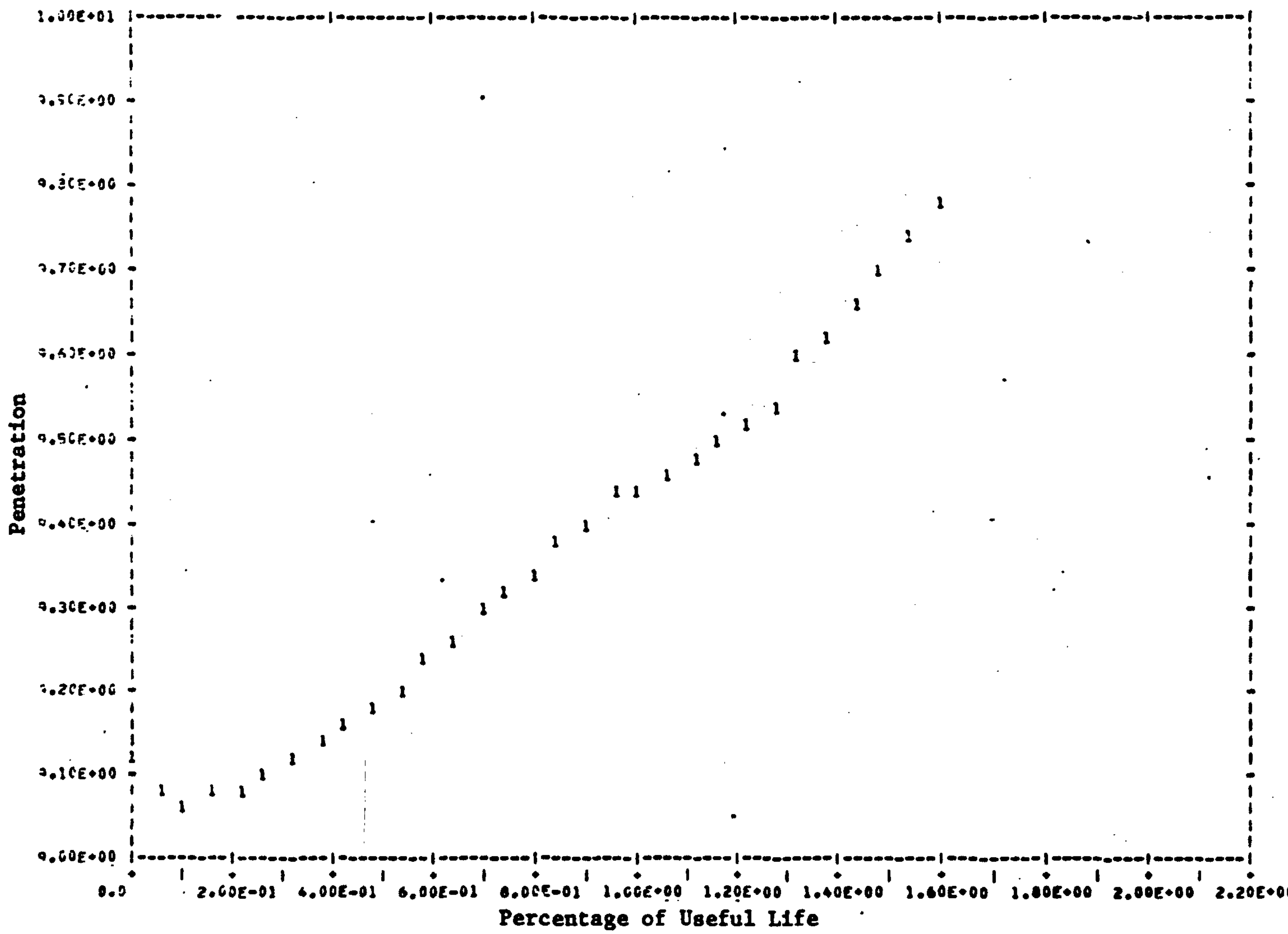


Figure 114 - Penetration of Gage 4 in GM1

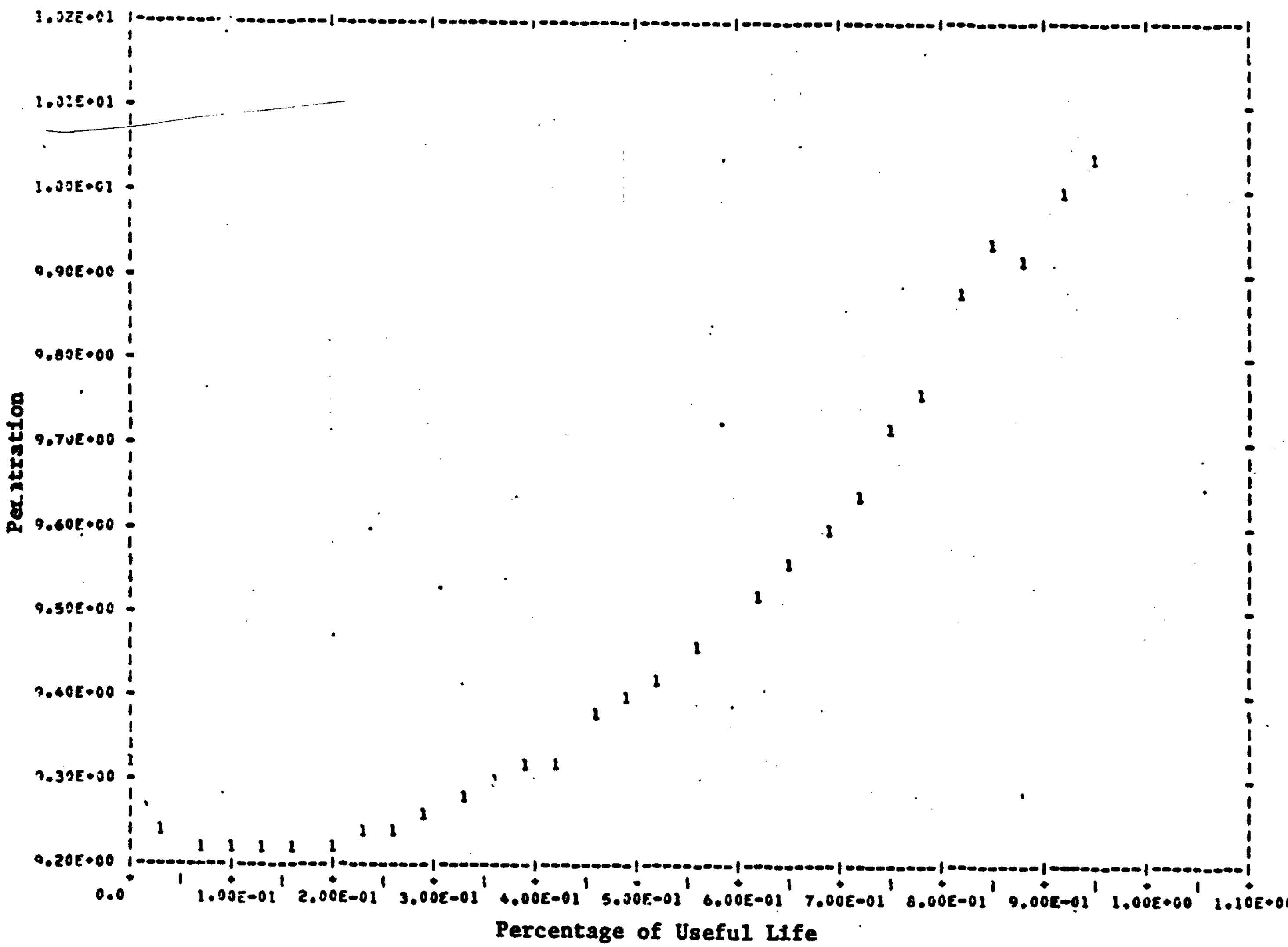


Figure 115 - Penetration of Gage 4 in GM2

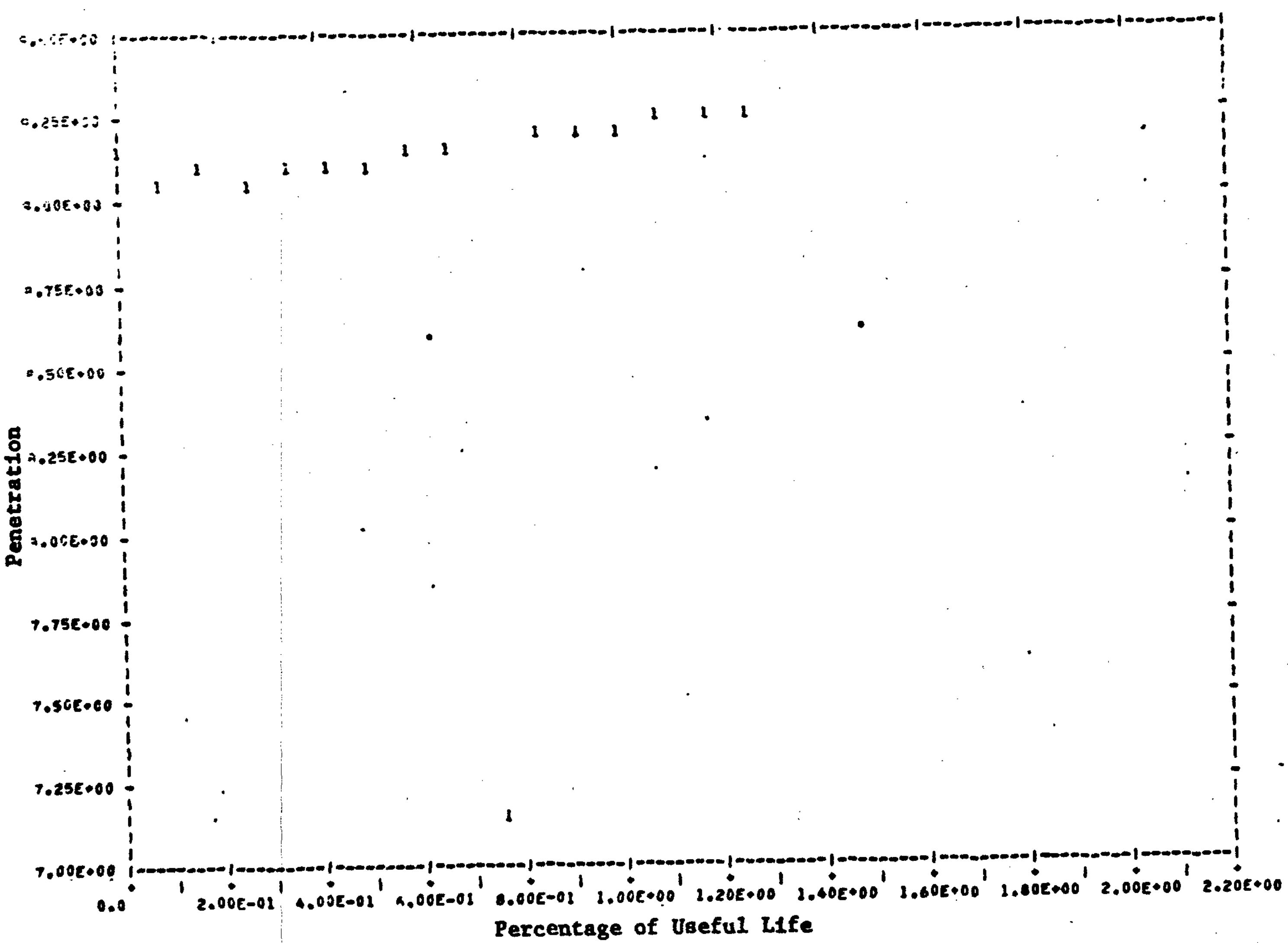


Figure 116 - Penetrction of Gage 4 in GM4

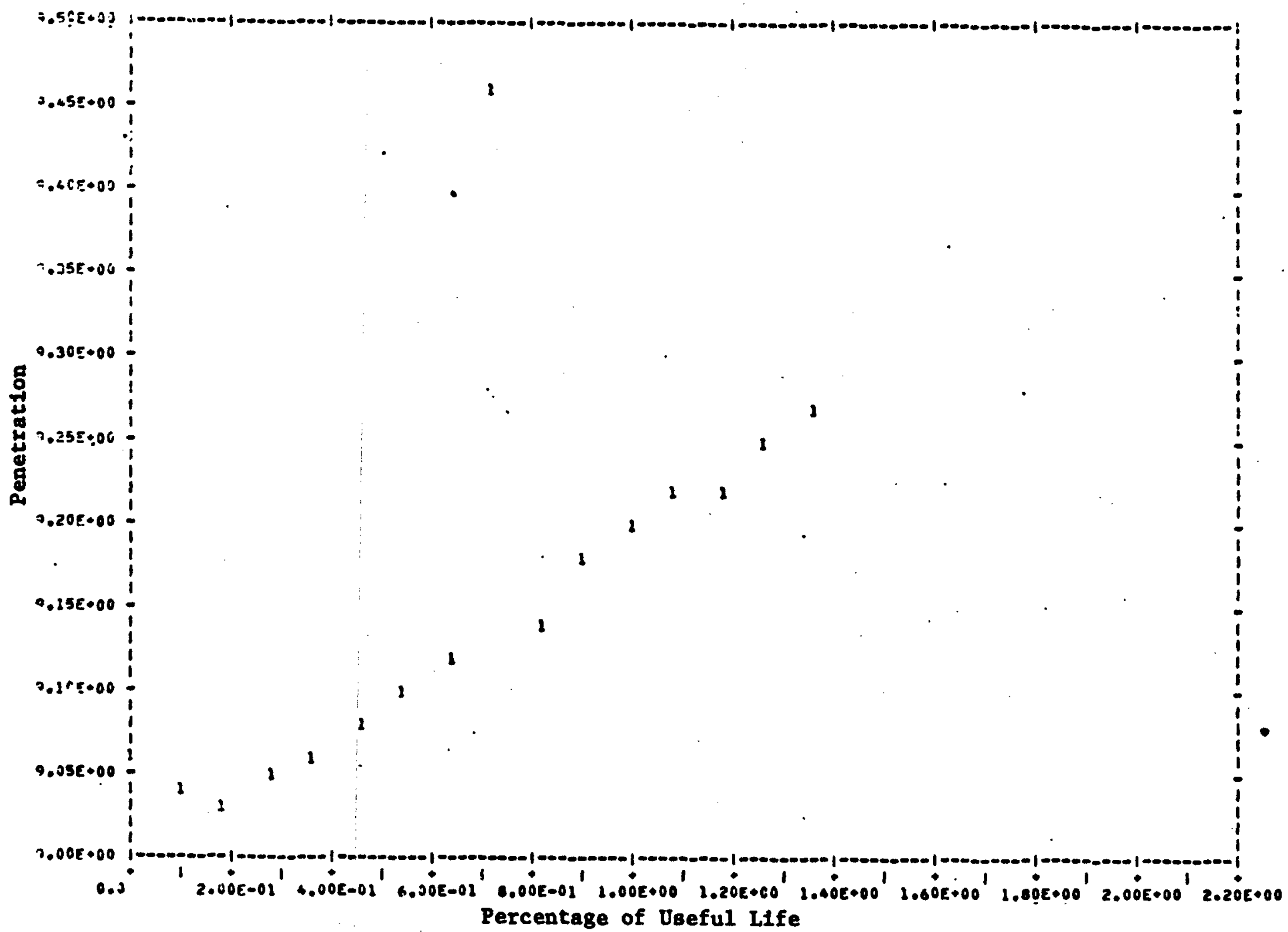


Figure 117 - Penetration of Gage 4 in GML

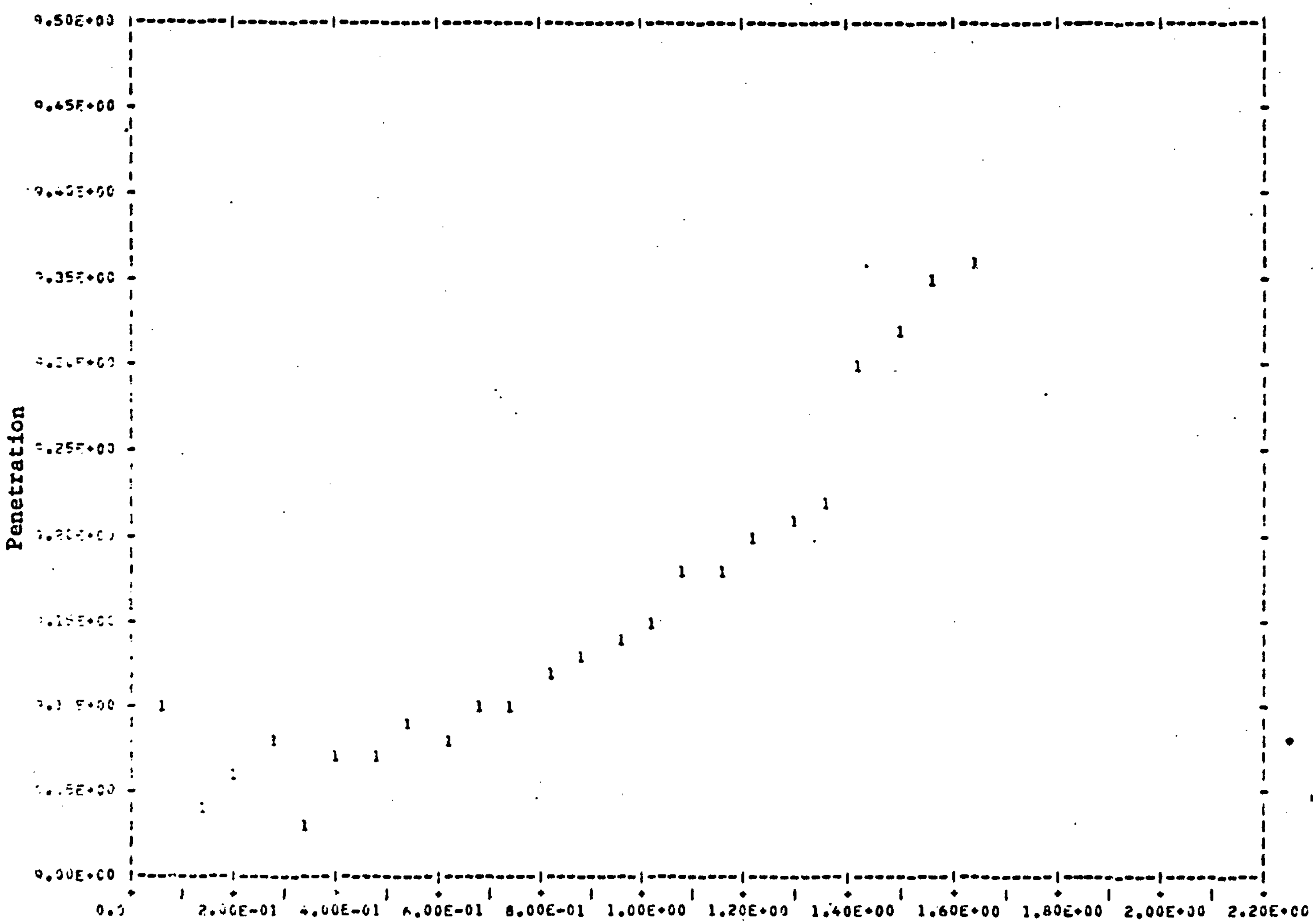


Figure 118 - Penetration of Gage 4 in GM7

BEST AVAILABLE COPY

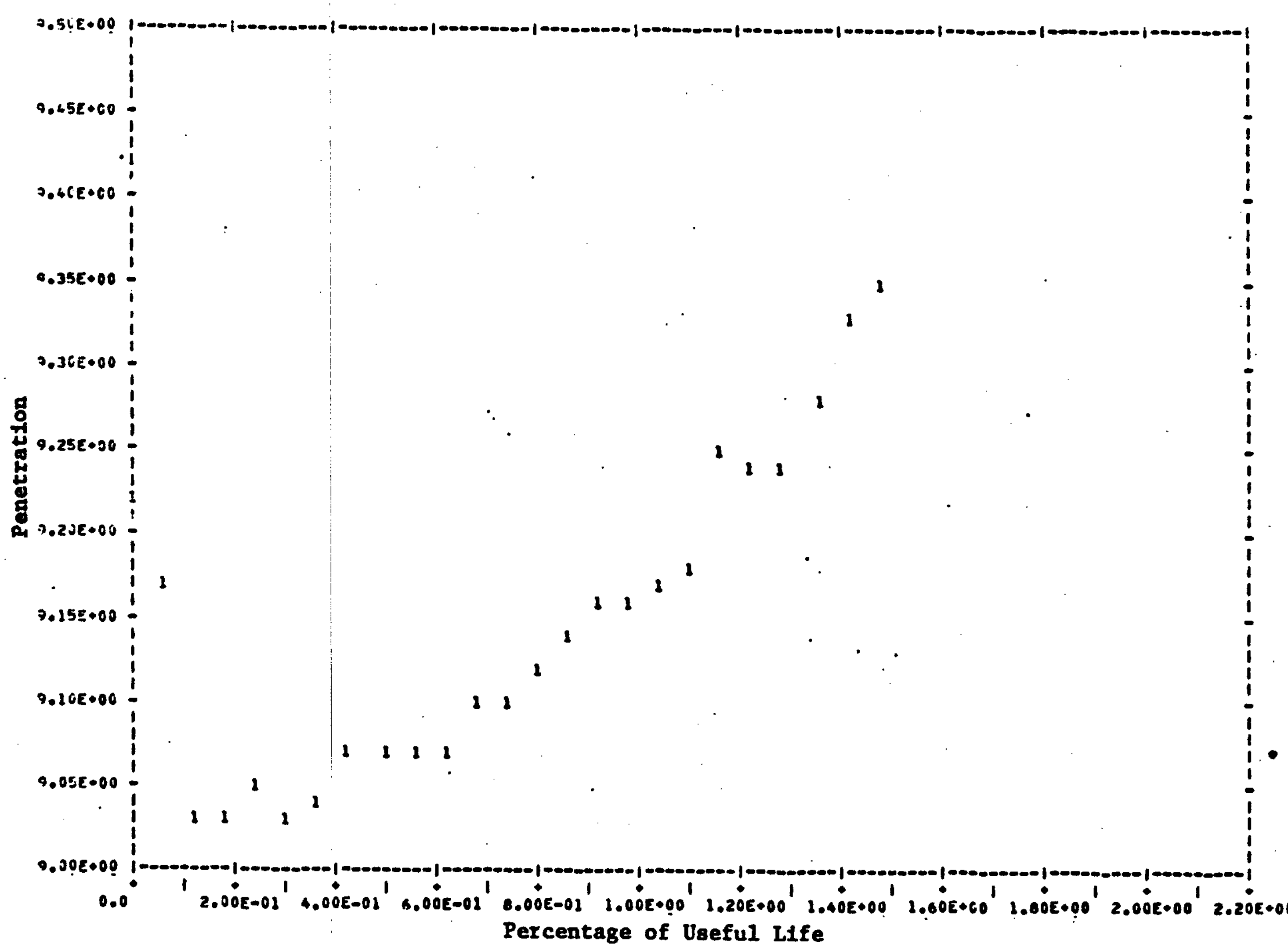


Figure 119 - Penetration of Gage 4 in GM8

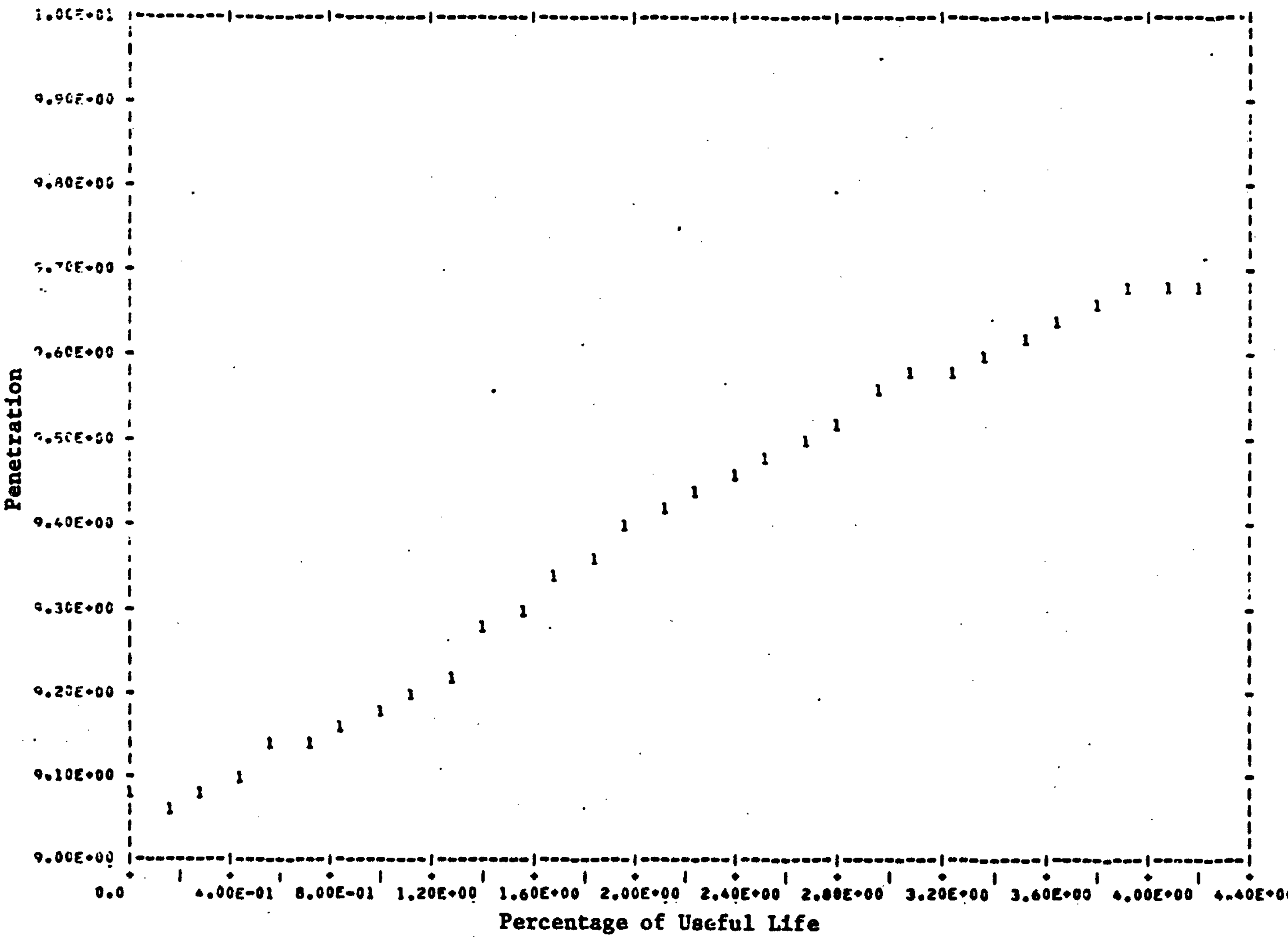


Figure 120 – Penetration of Gage 4 in M1

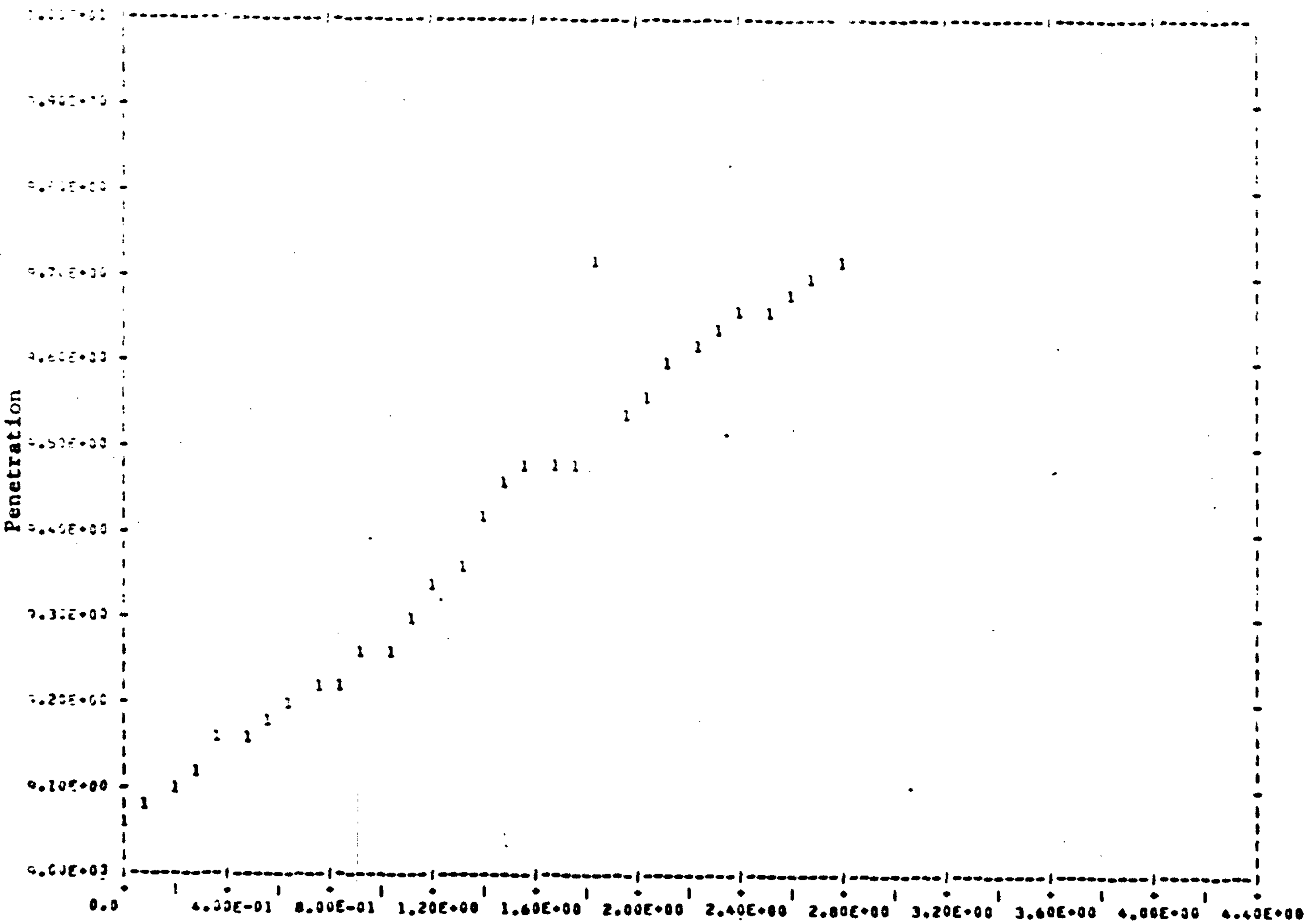


Figure 121 - Penetration of Gage 4 in M2

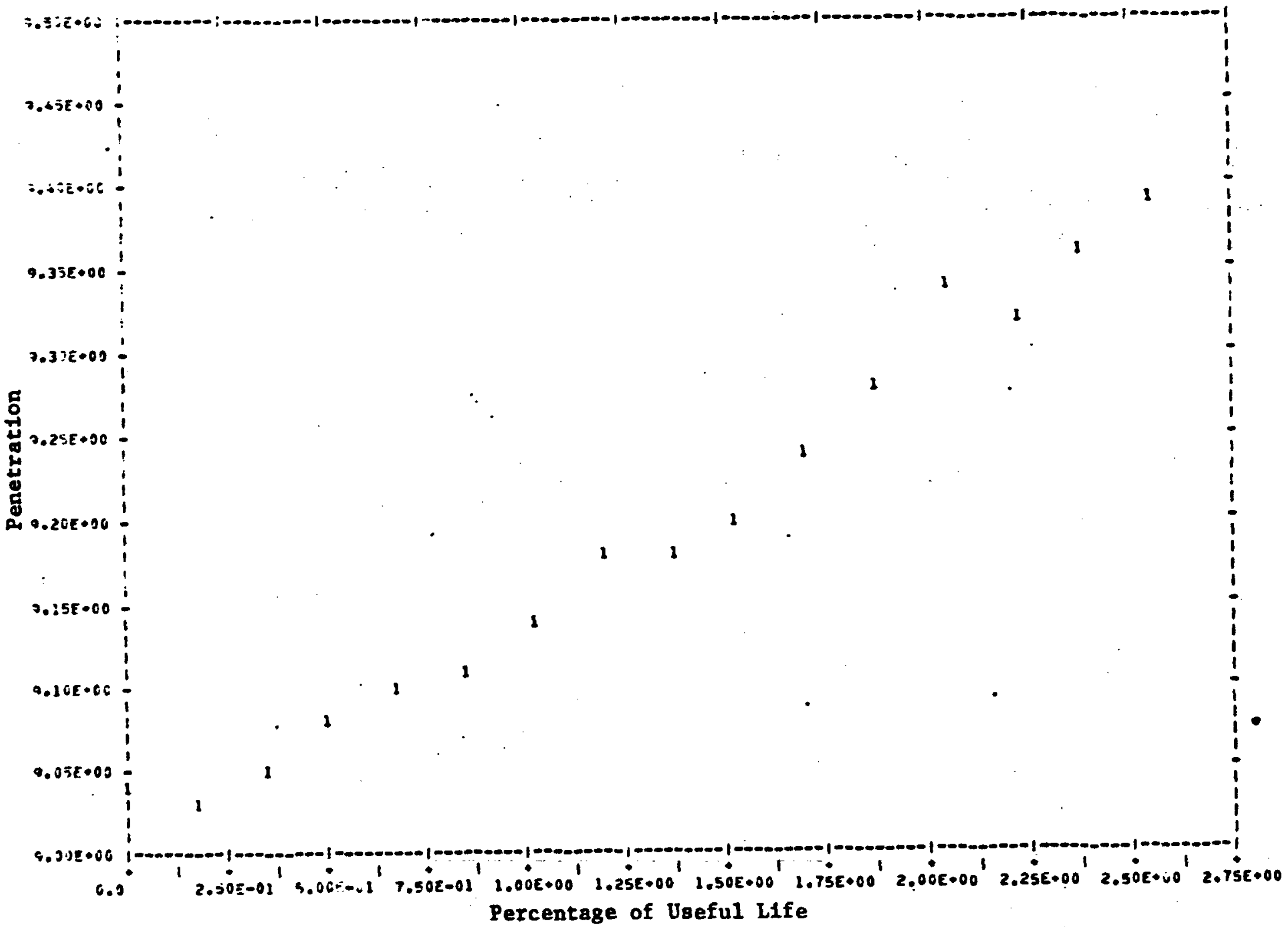


Figure 122 - Penetration of Gage 4 in M4

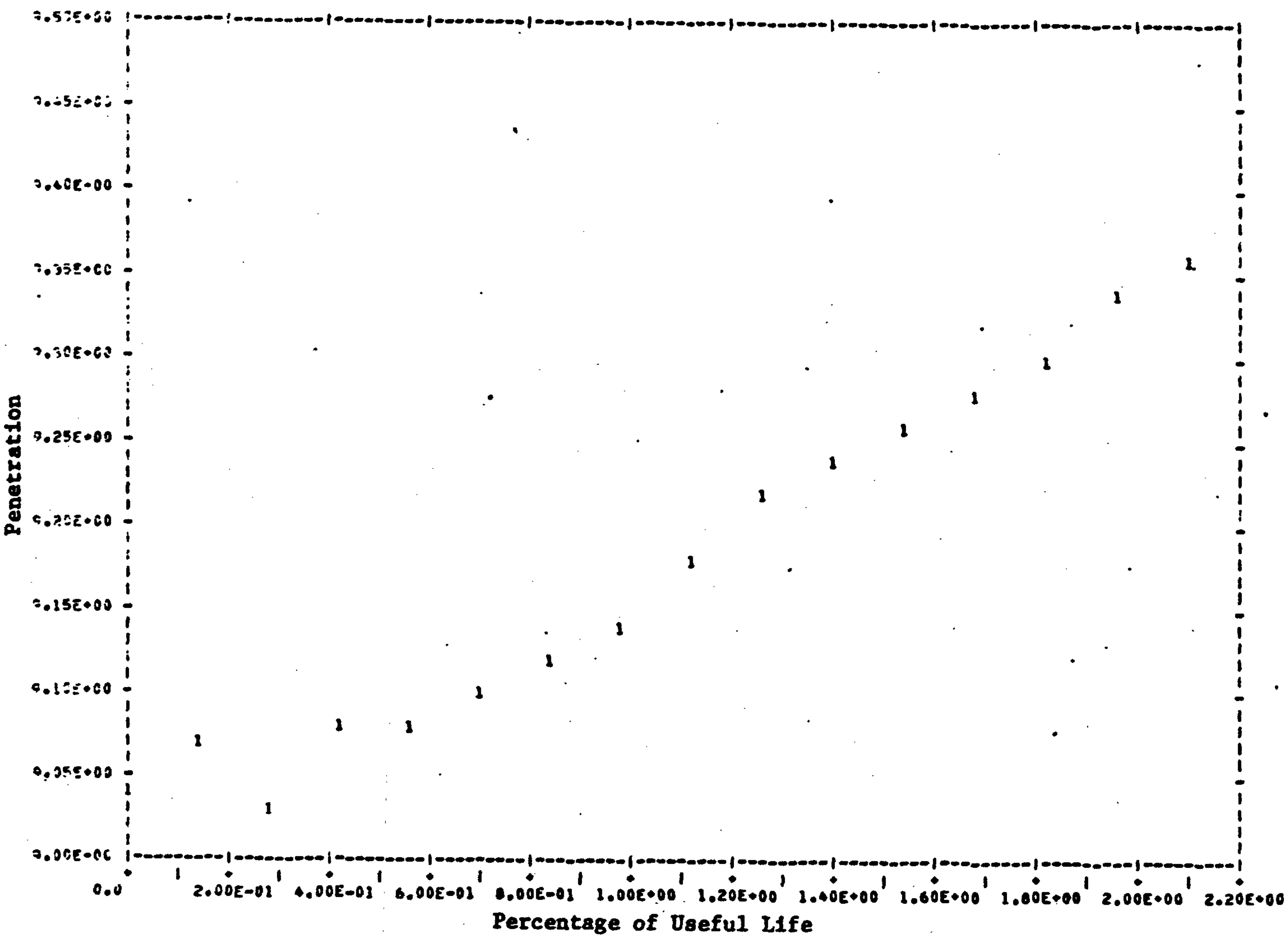


Figure 123 - Penetration of Gage 4 in M5

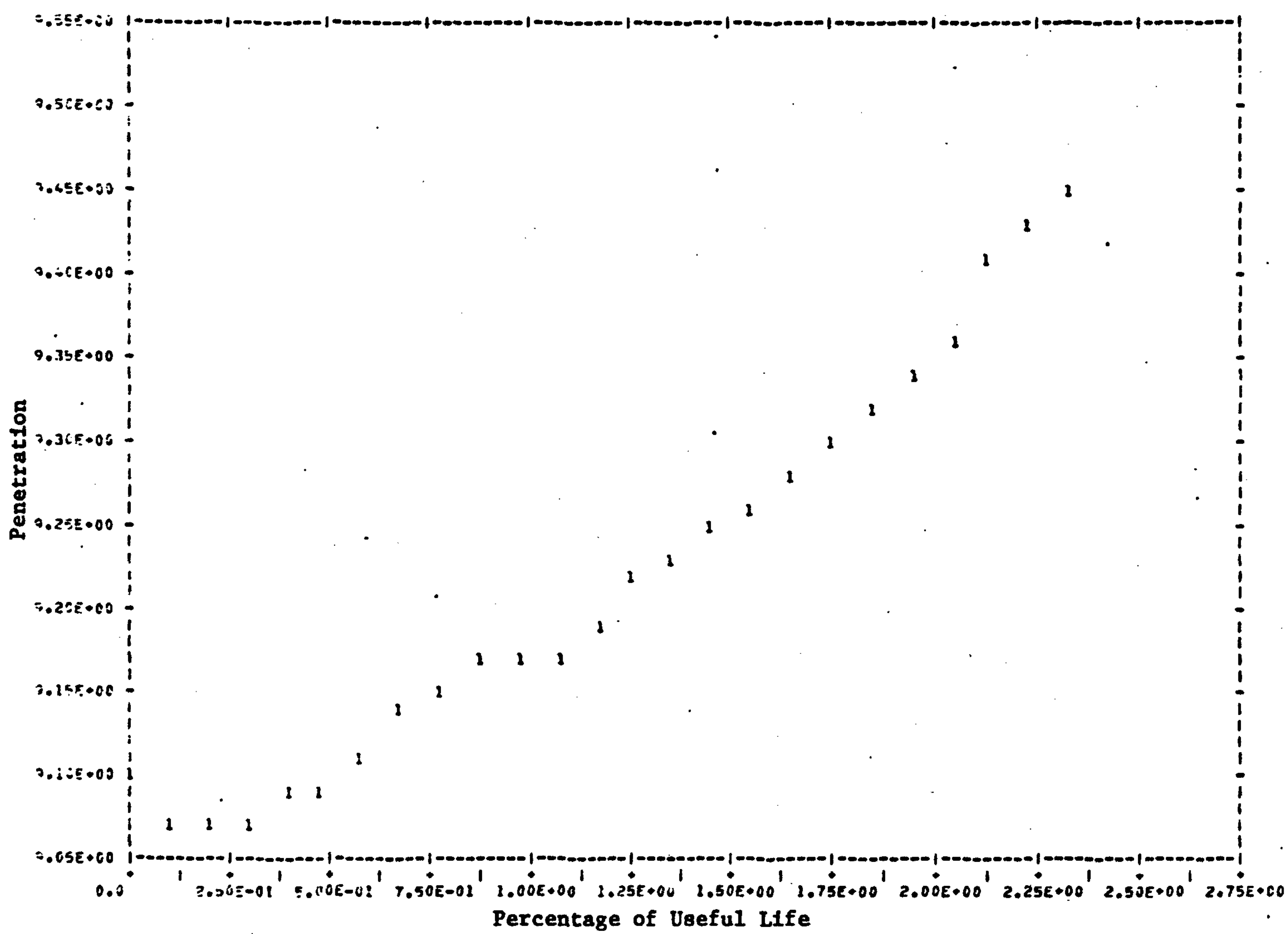


Figure 124 - Penetration of Gage 4 in M7

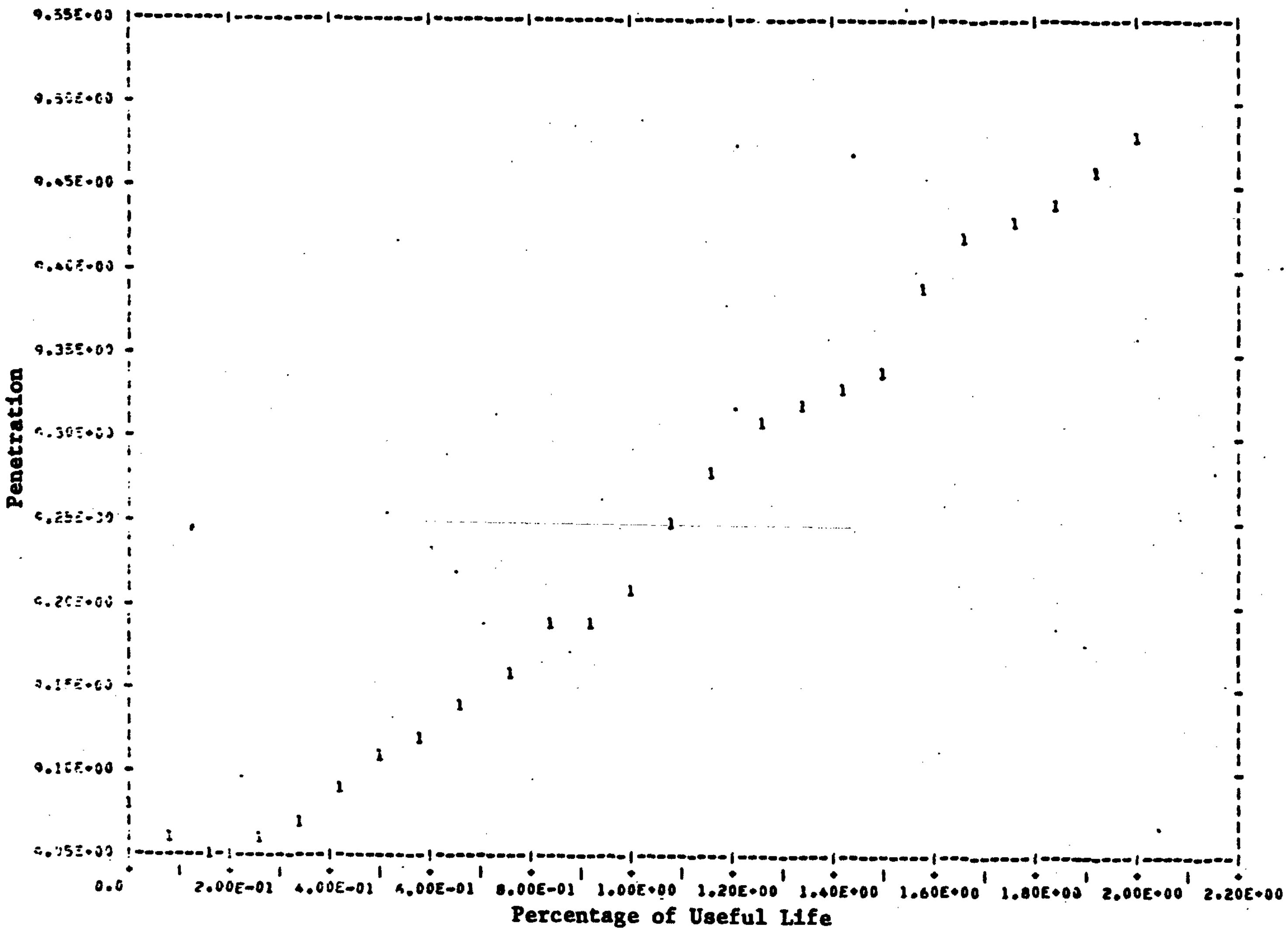


Figure 125 - Penetration of Gage 4 in M8

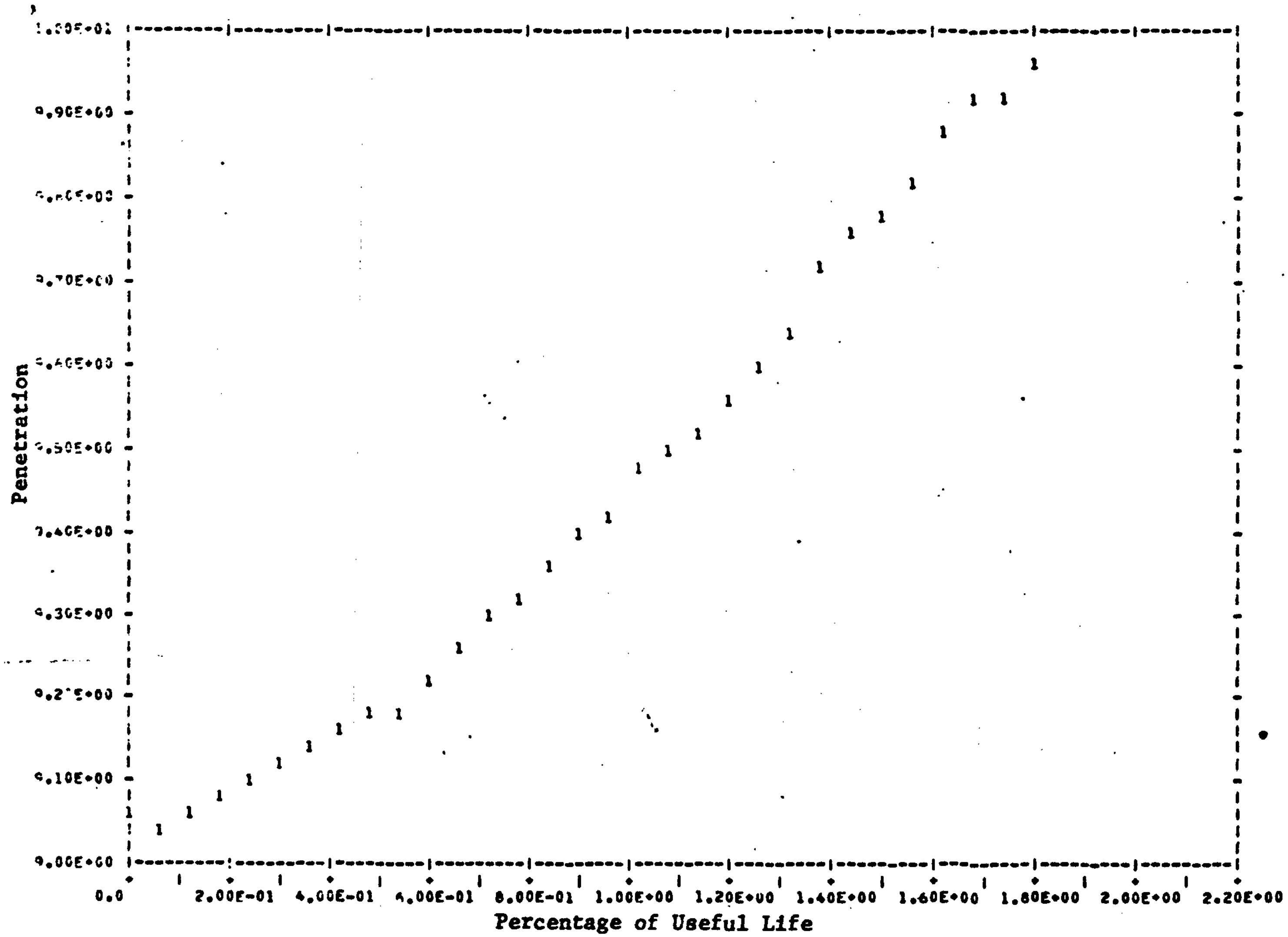


Figure 126 - Penetration of Gage 5 in C1

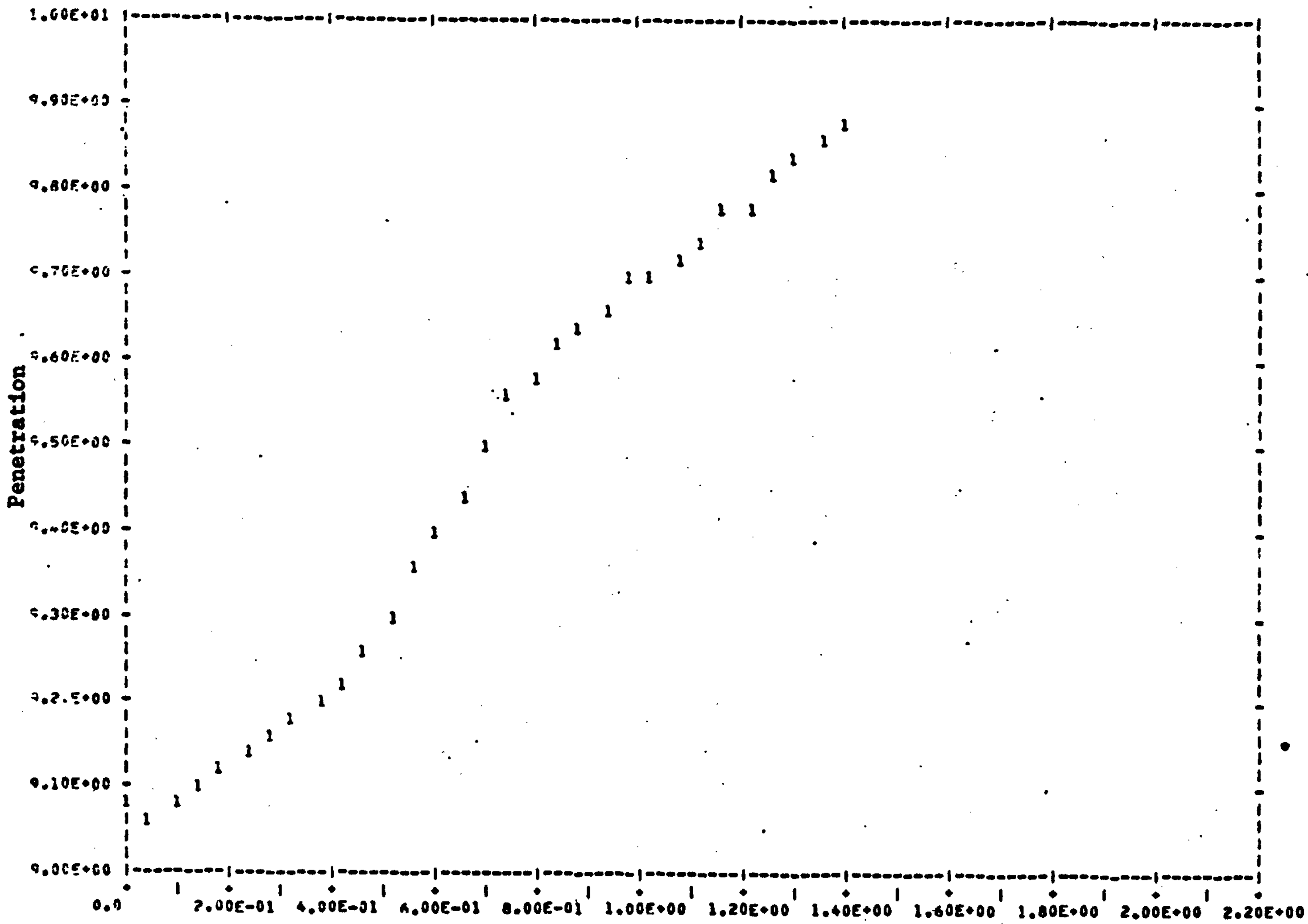


Figure 127 - Penetration of Gage 5 in C2

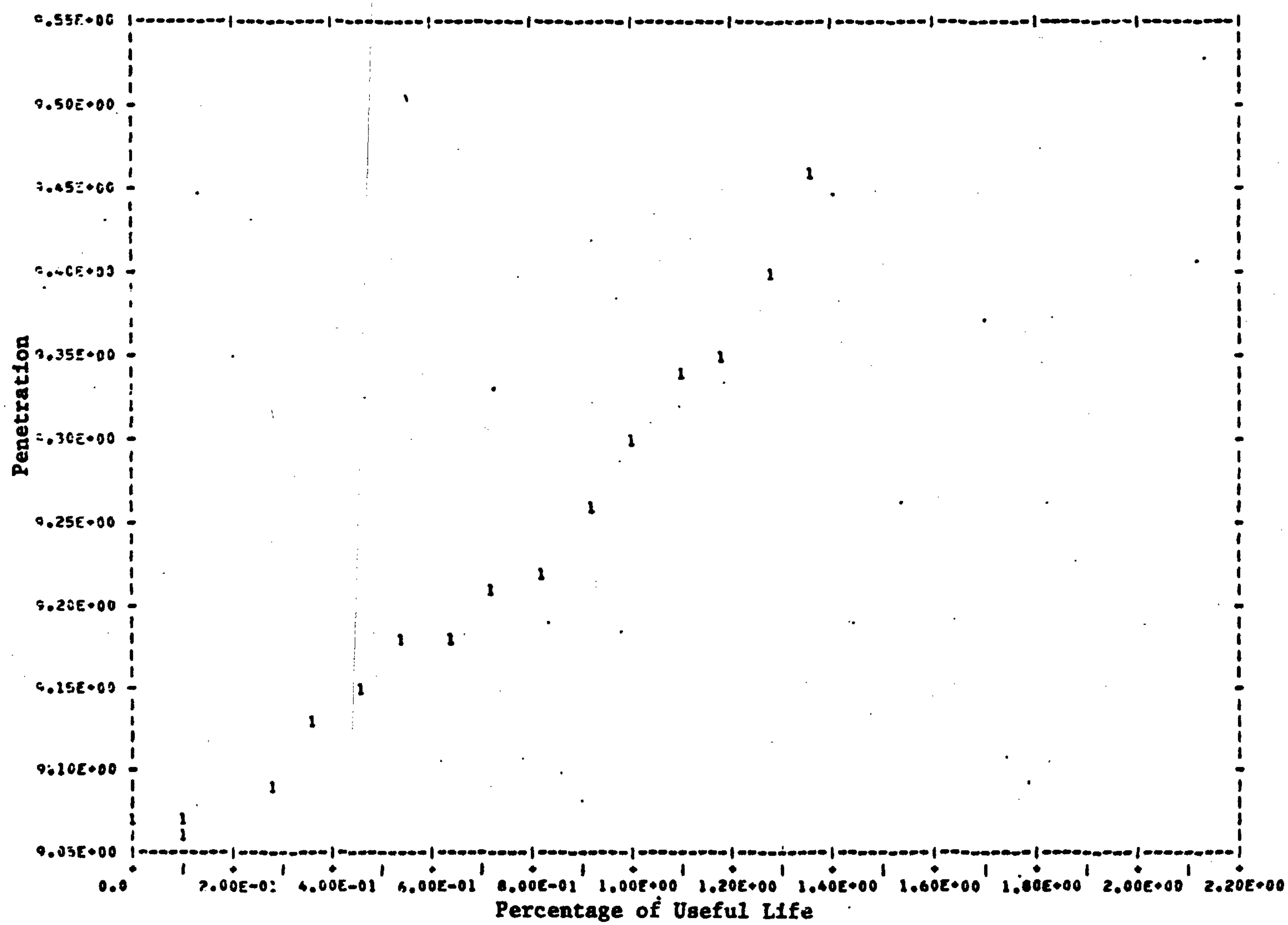


Figure 128 - Penetration of Gage 5 in C4

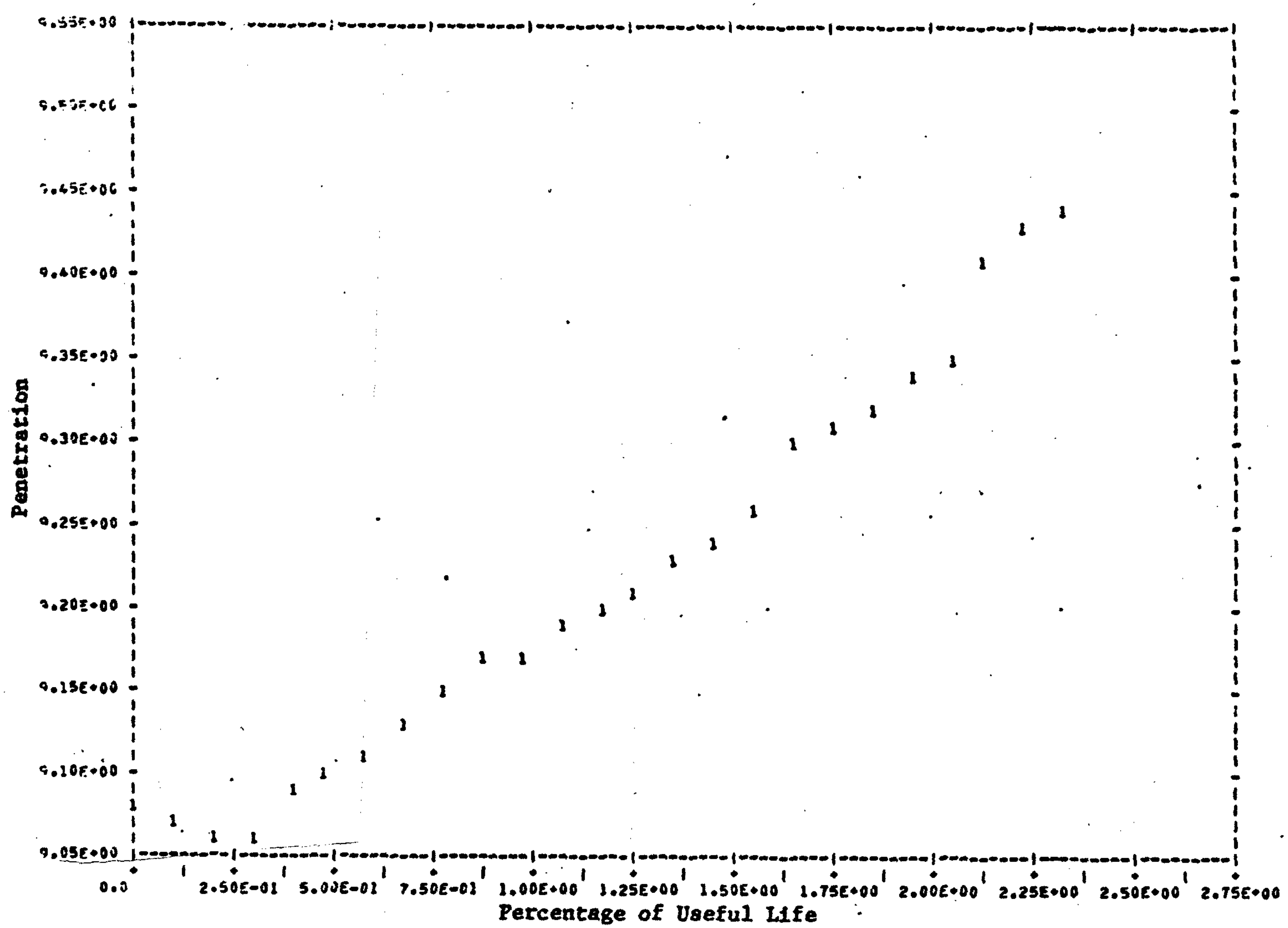


Figure 129 - Penetration of Gage 5 in C5

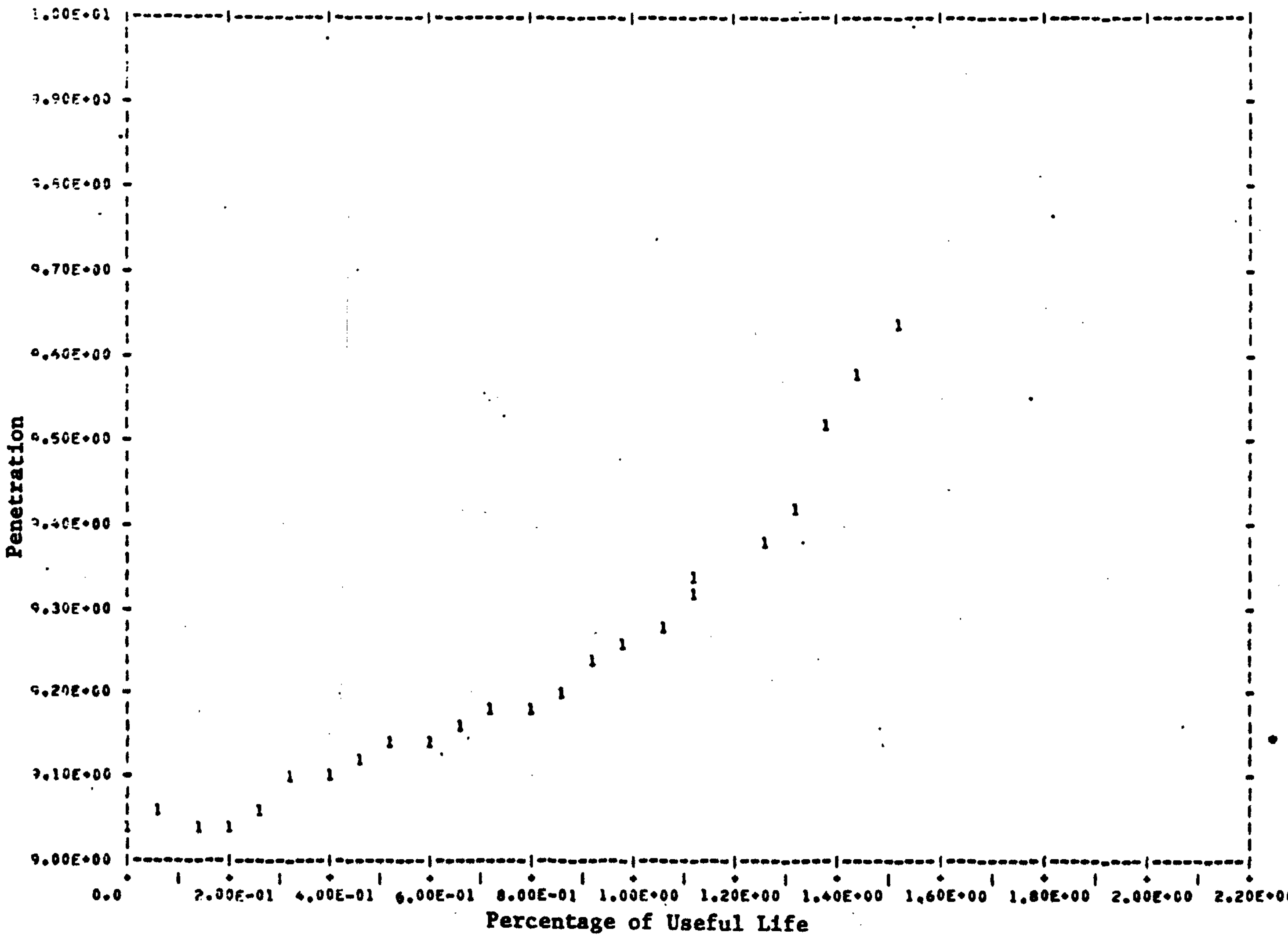


Figure 130 - Penetration of Gage 5 in C7

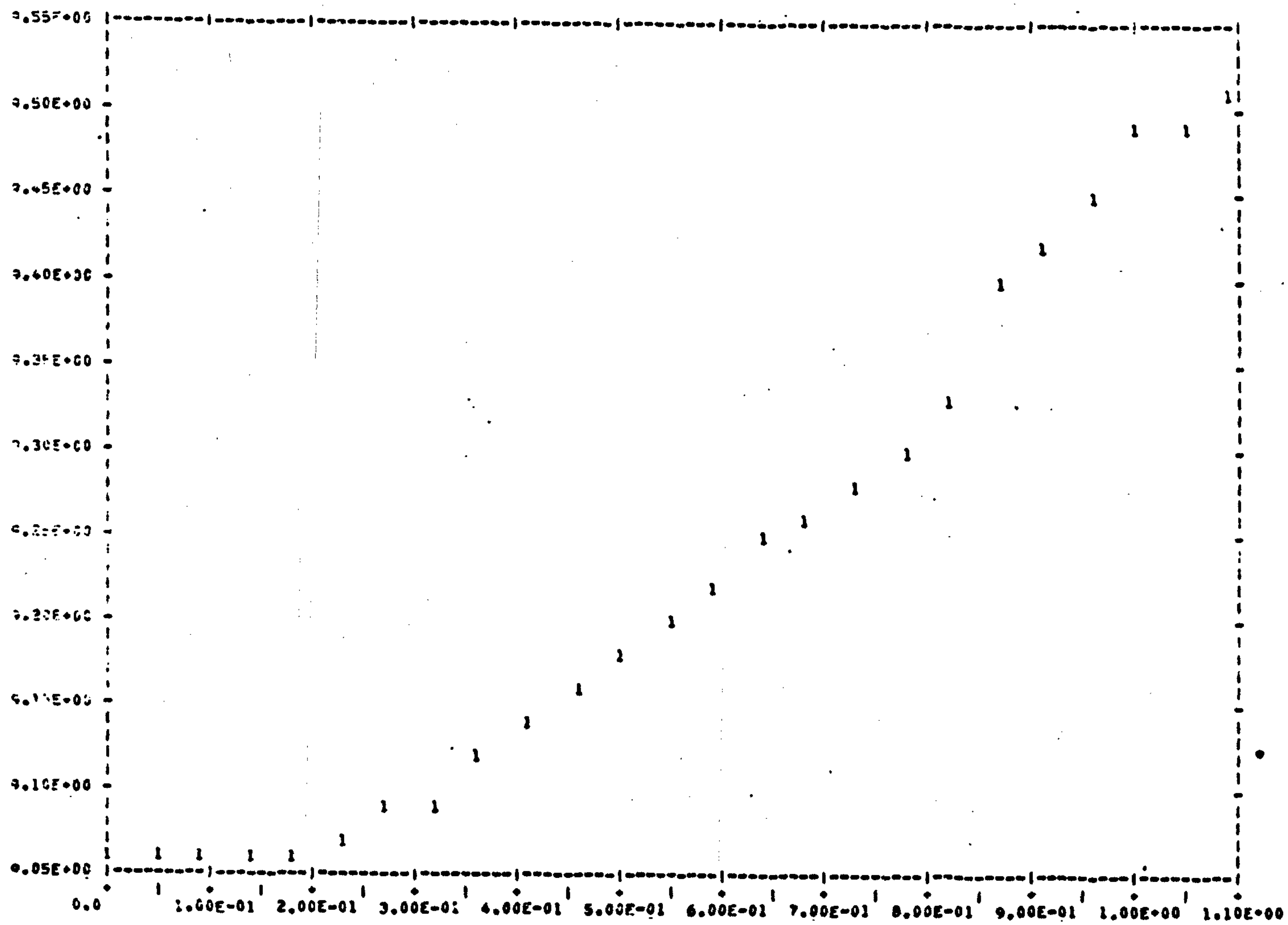


Figure 131 - Penetration of Gage 5 in C8

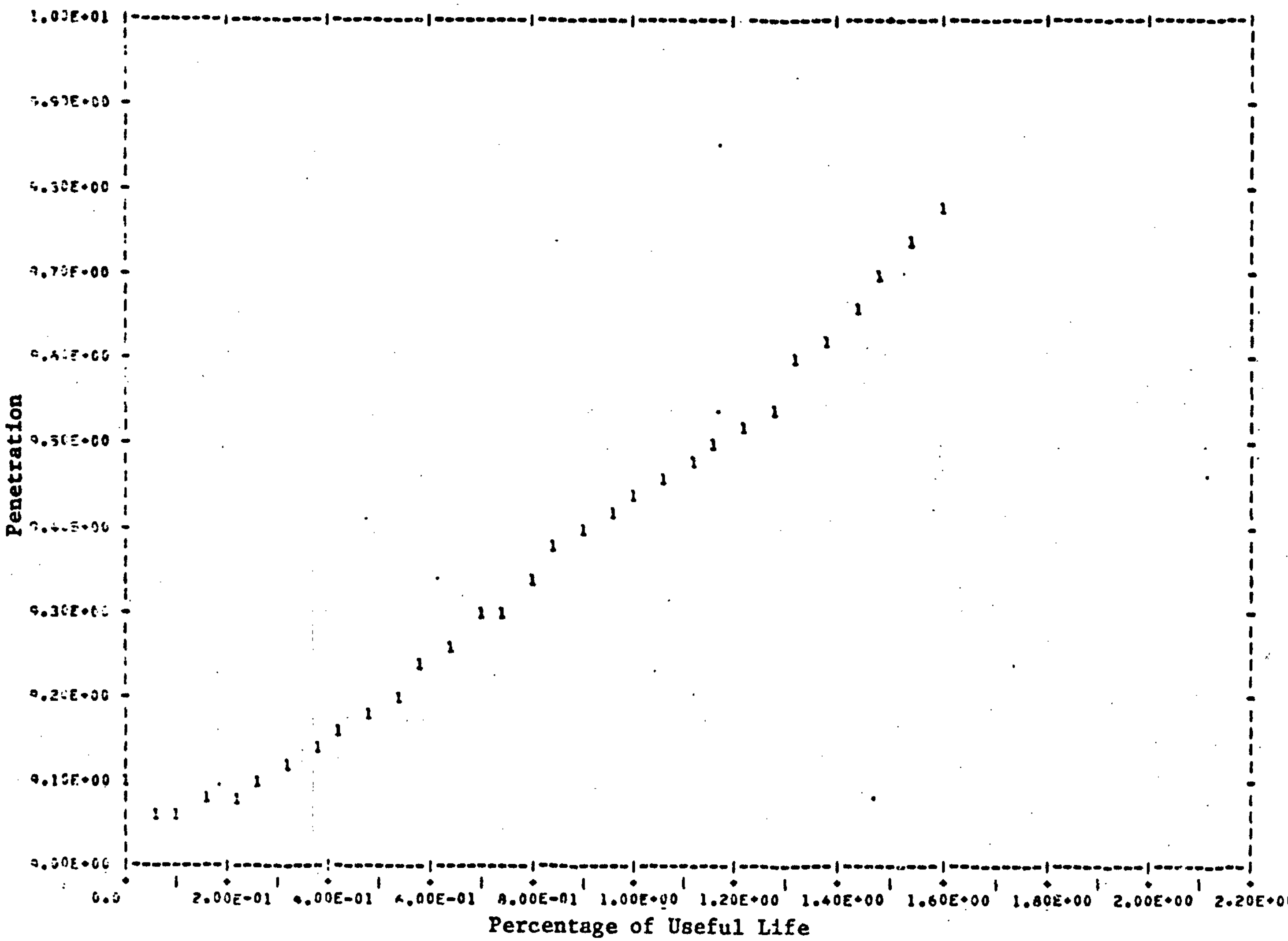


Figure 132 - Penetration of Gage 5 in GM1

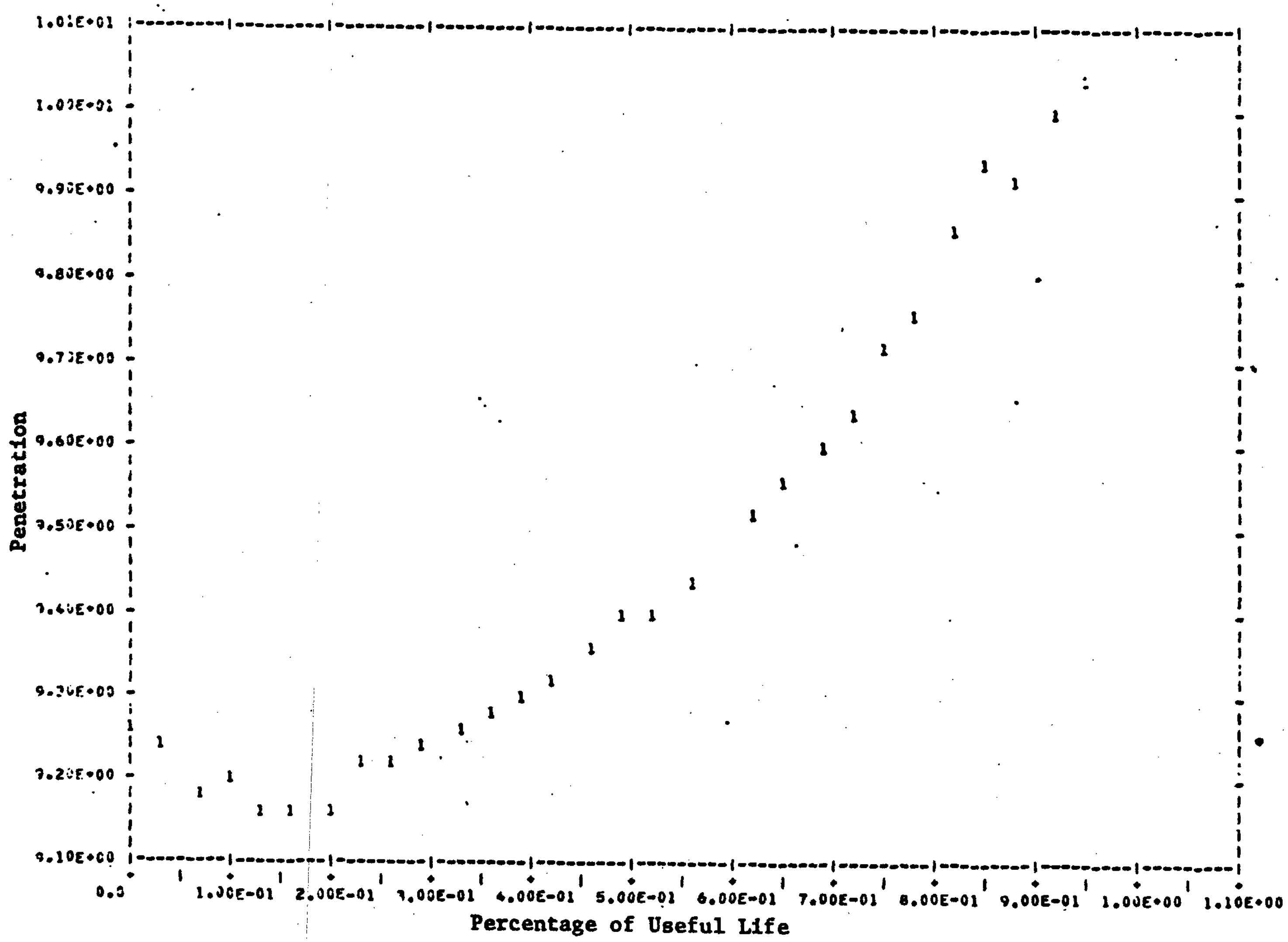


Figure 133 - Penetration of Gage 5 in GM2

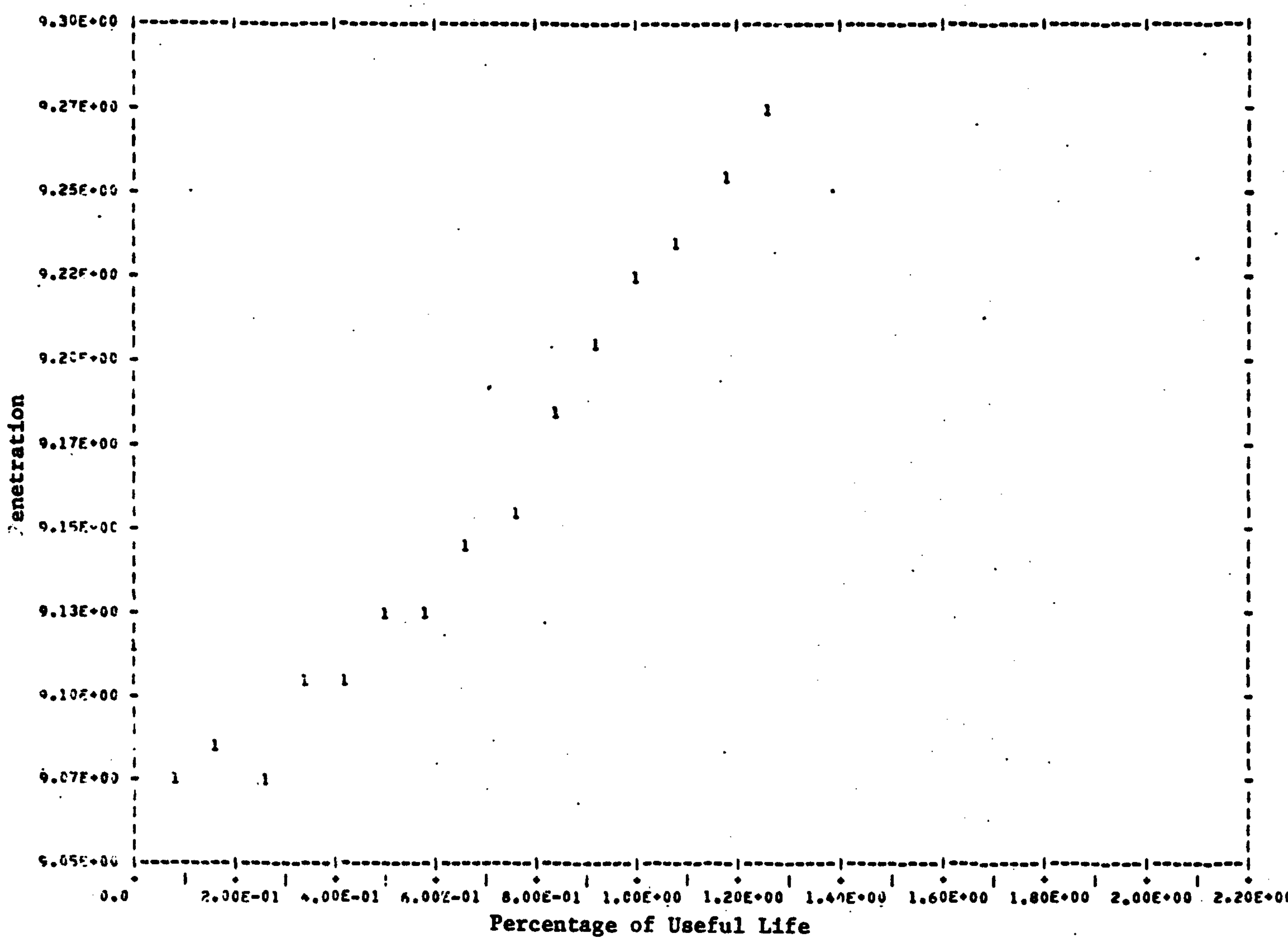


Figure 134 - Penetration of Gage 5 in GM4

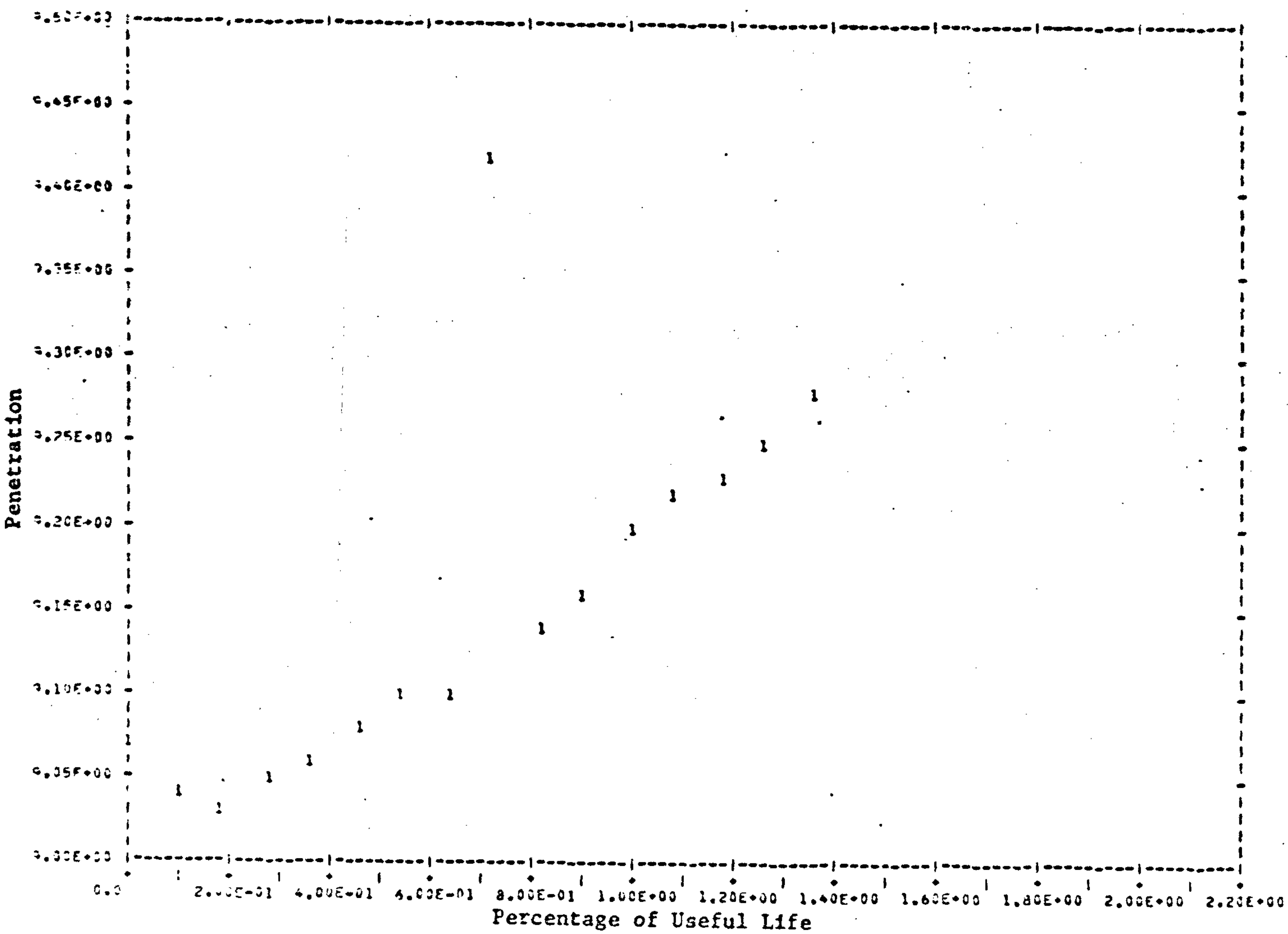


Figure 135 - Penetration of Gage 5 in GM5

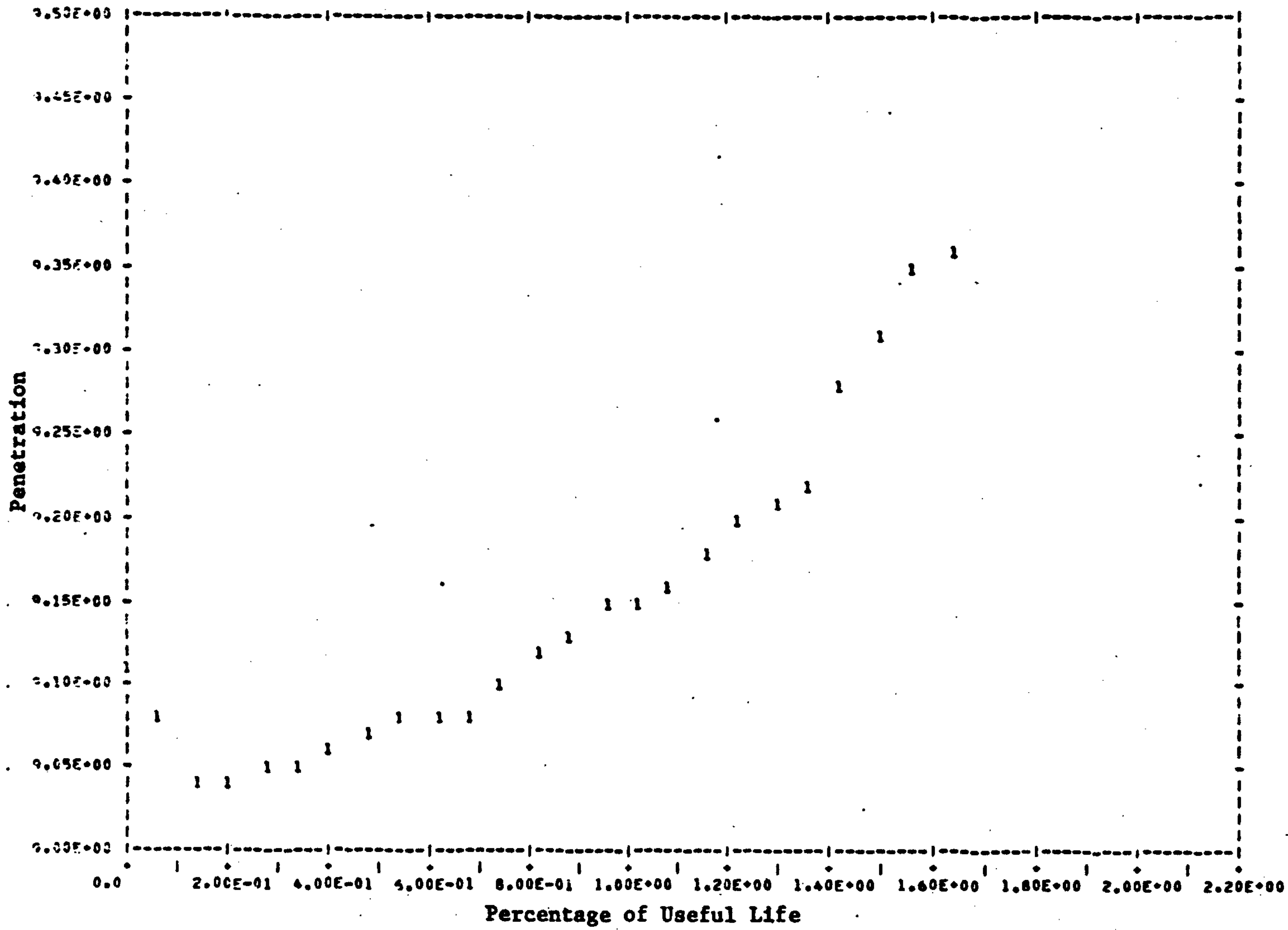


Figure 136 - Penetration of Gage 5 in GM7

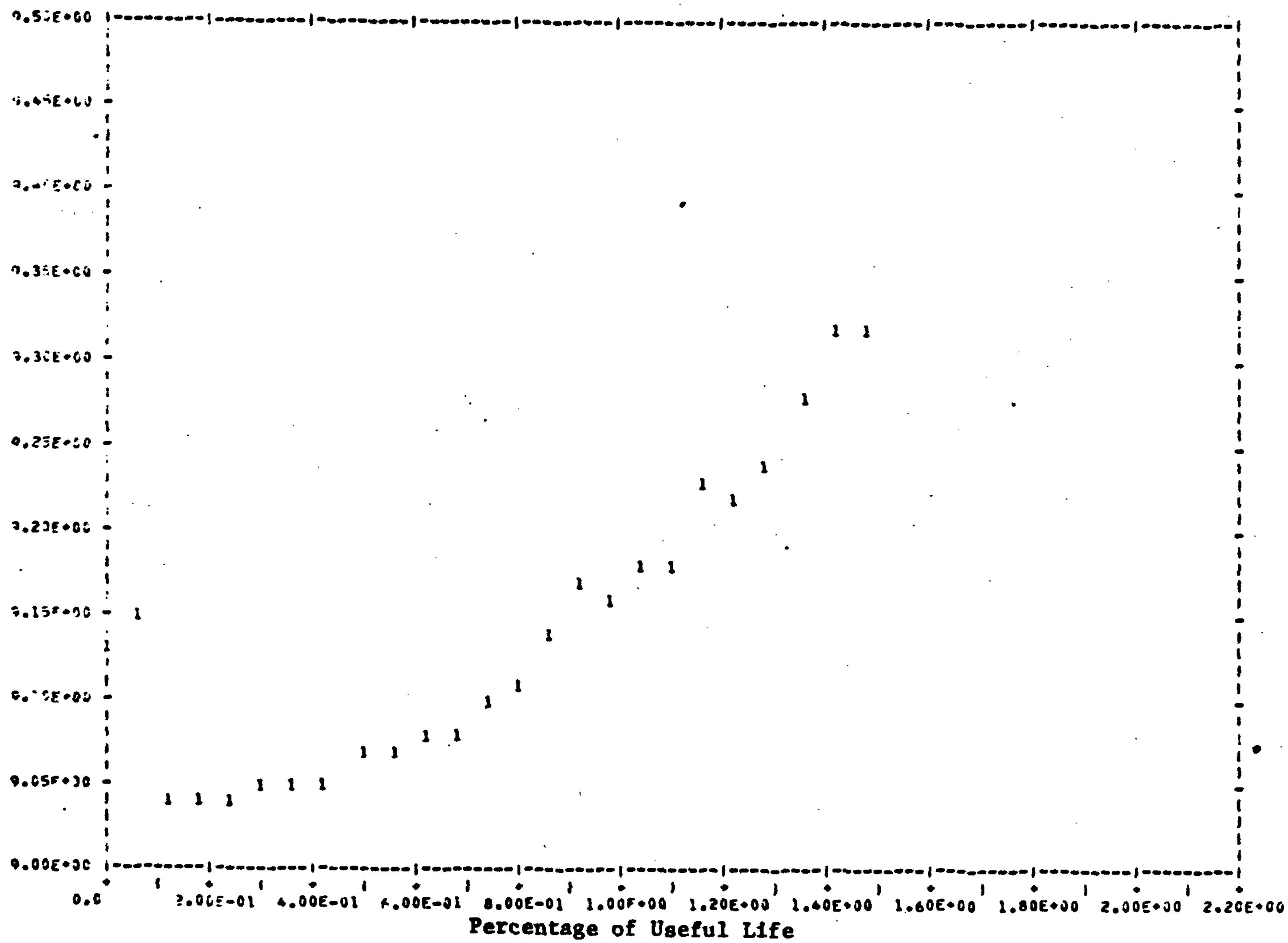


Figure 137 - Penetration of Gage 5 in GM8

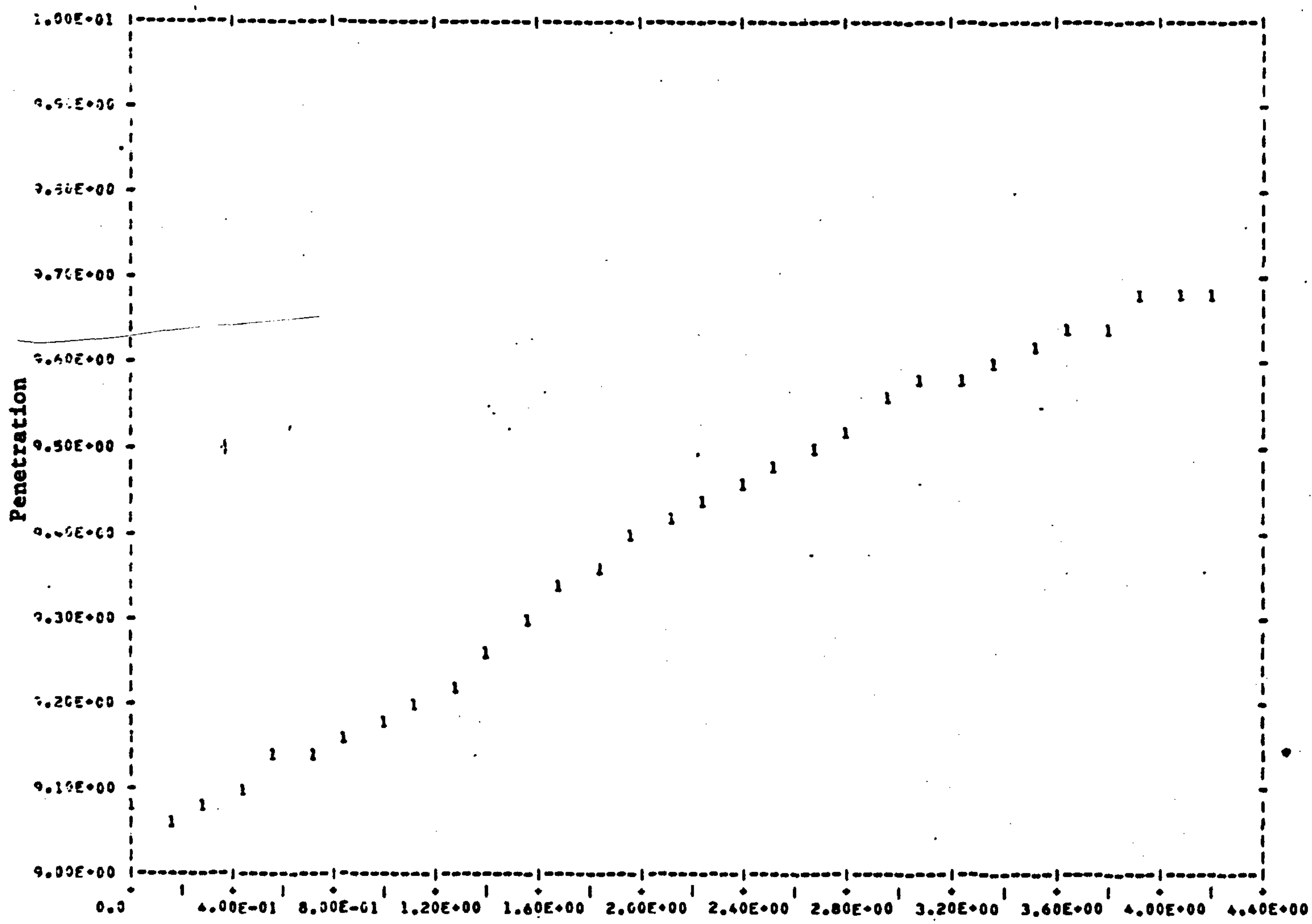


Figure 138 - Penetration of Gage 5 in M1

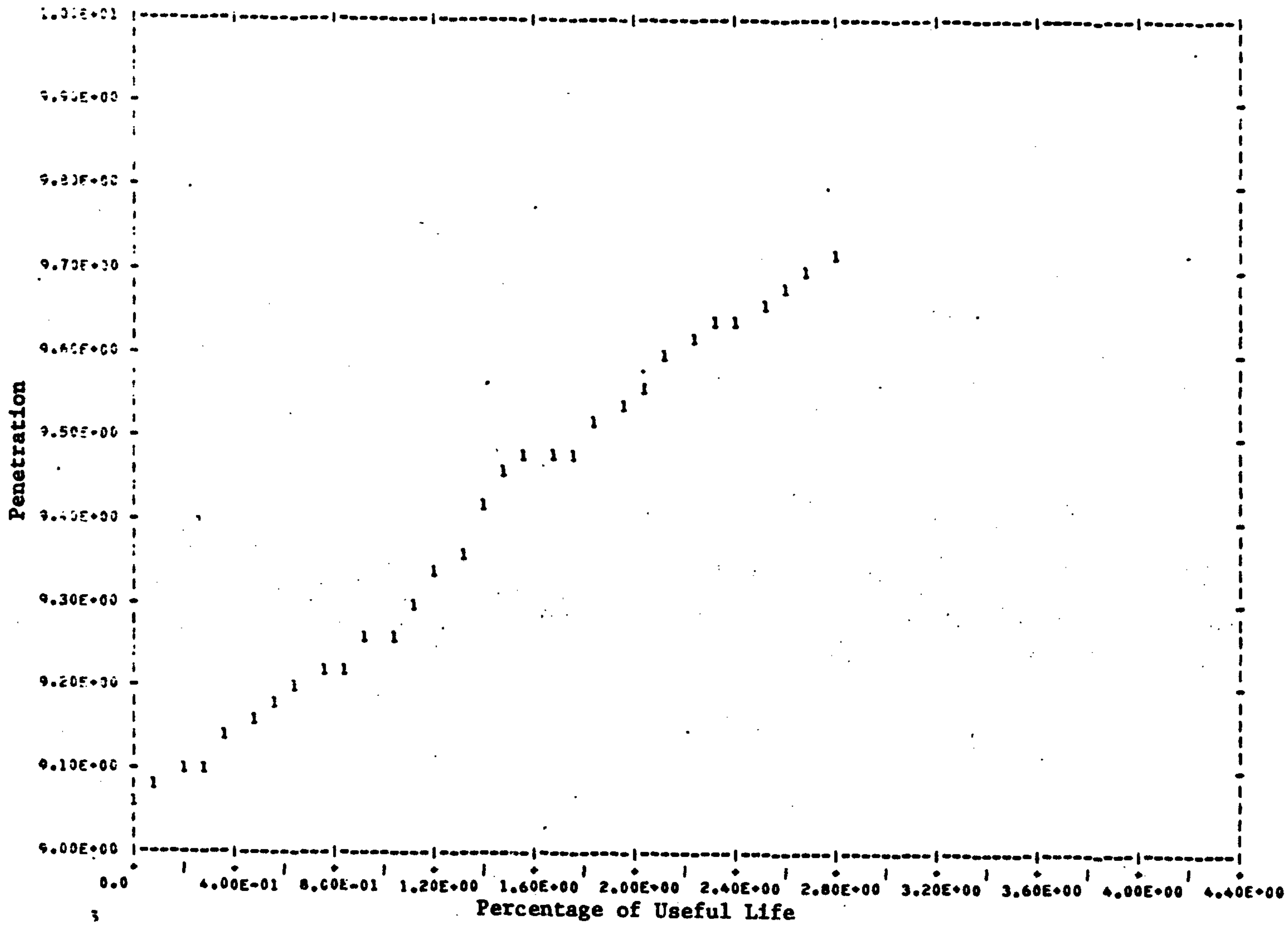


Figure 139 - Penetration of Gage 5 in M2

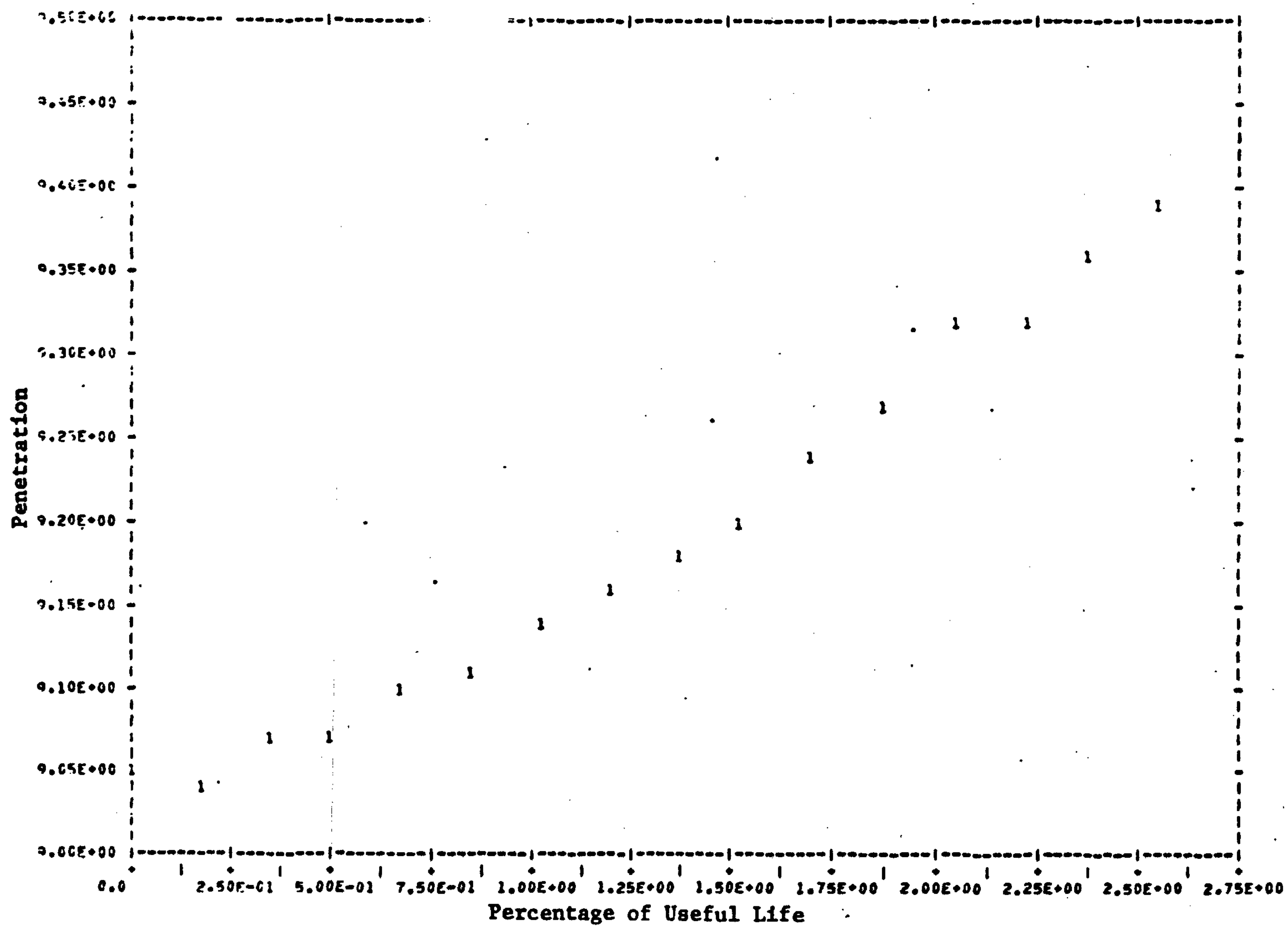


Figure 140 - Penetration of Gage 5 in M4

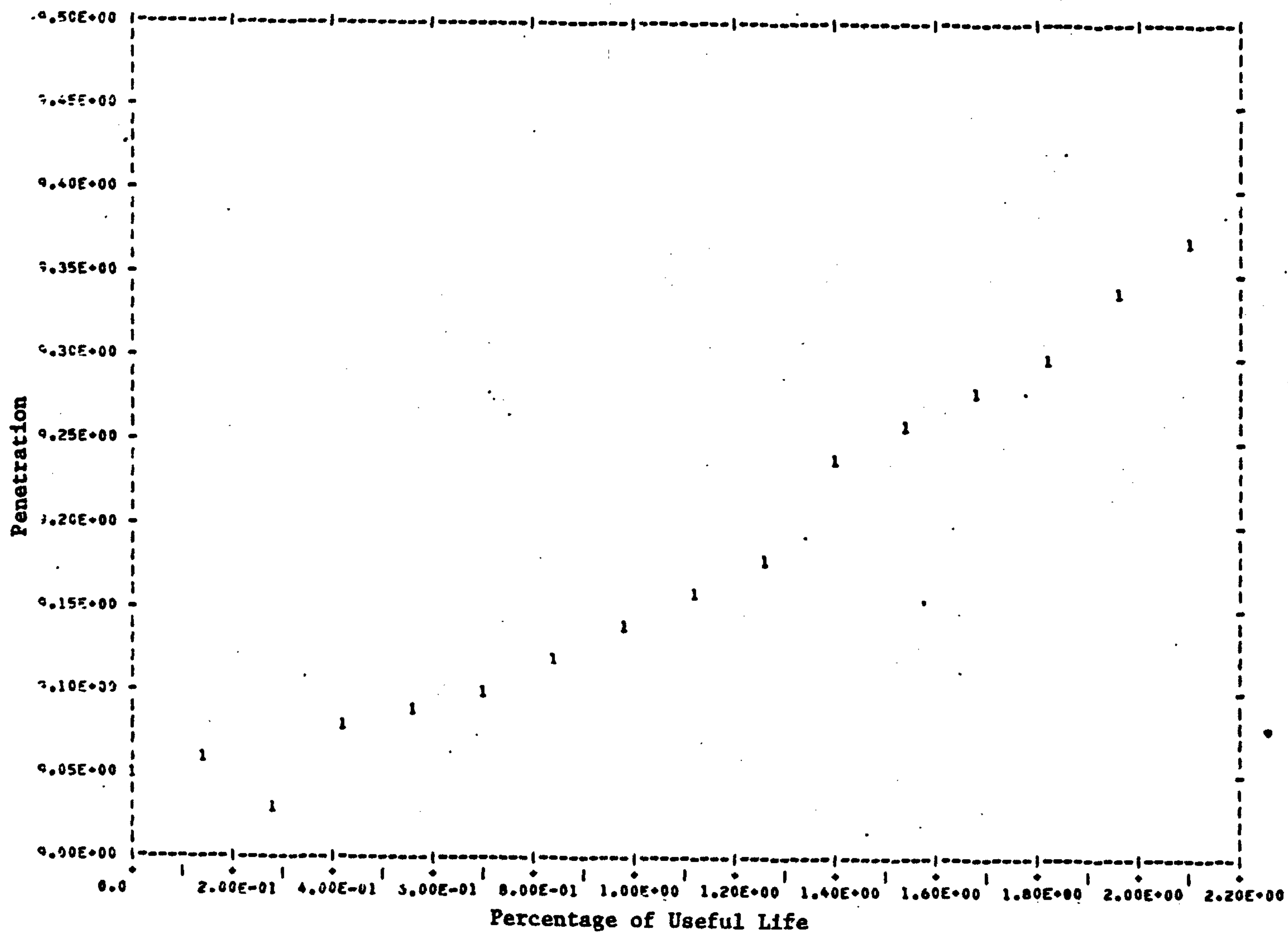


Figure 141 - Penetration of Gage 5 in M5

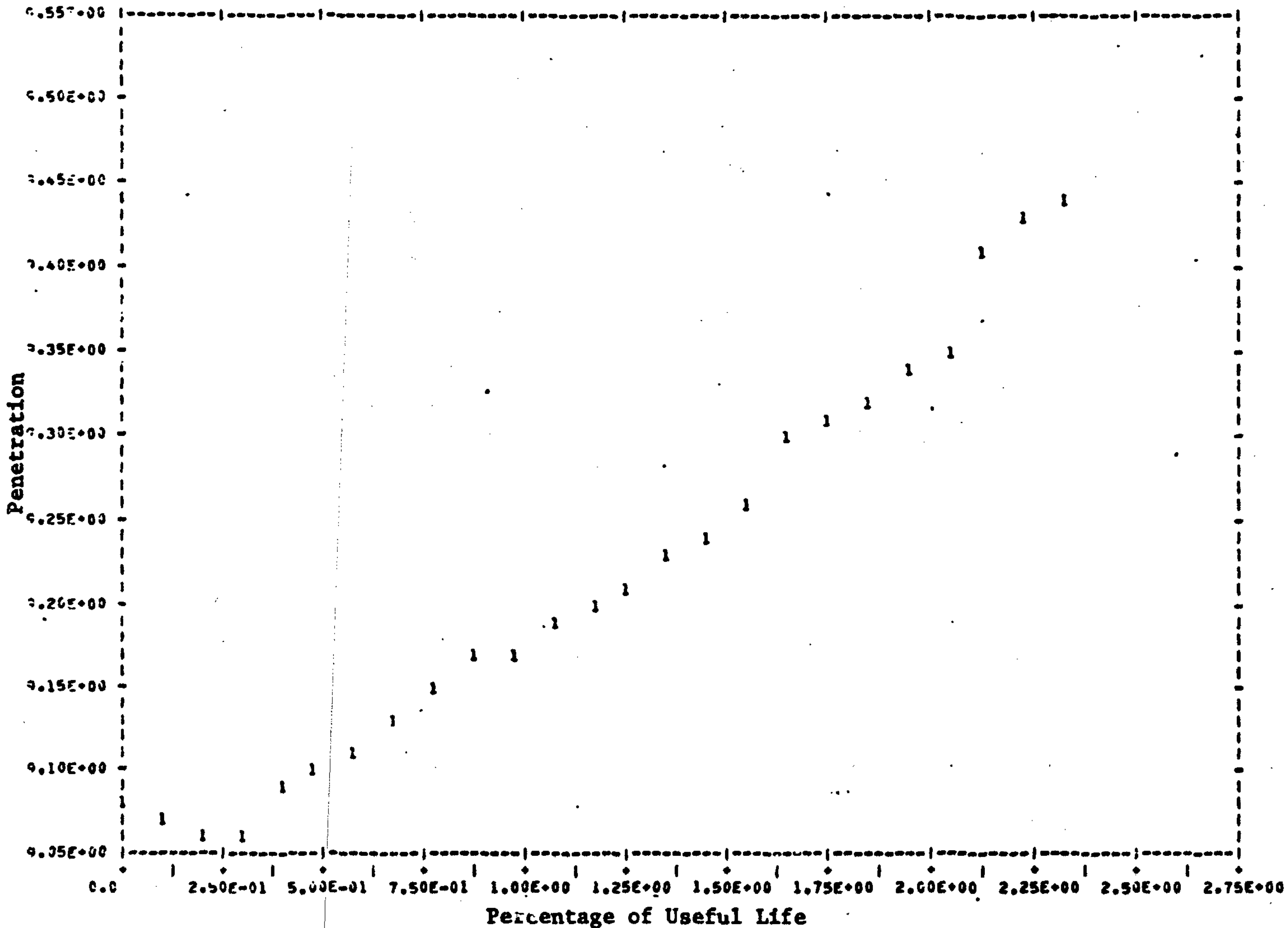


Figure 142 - Penetration of Gage 5 in M7

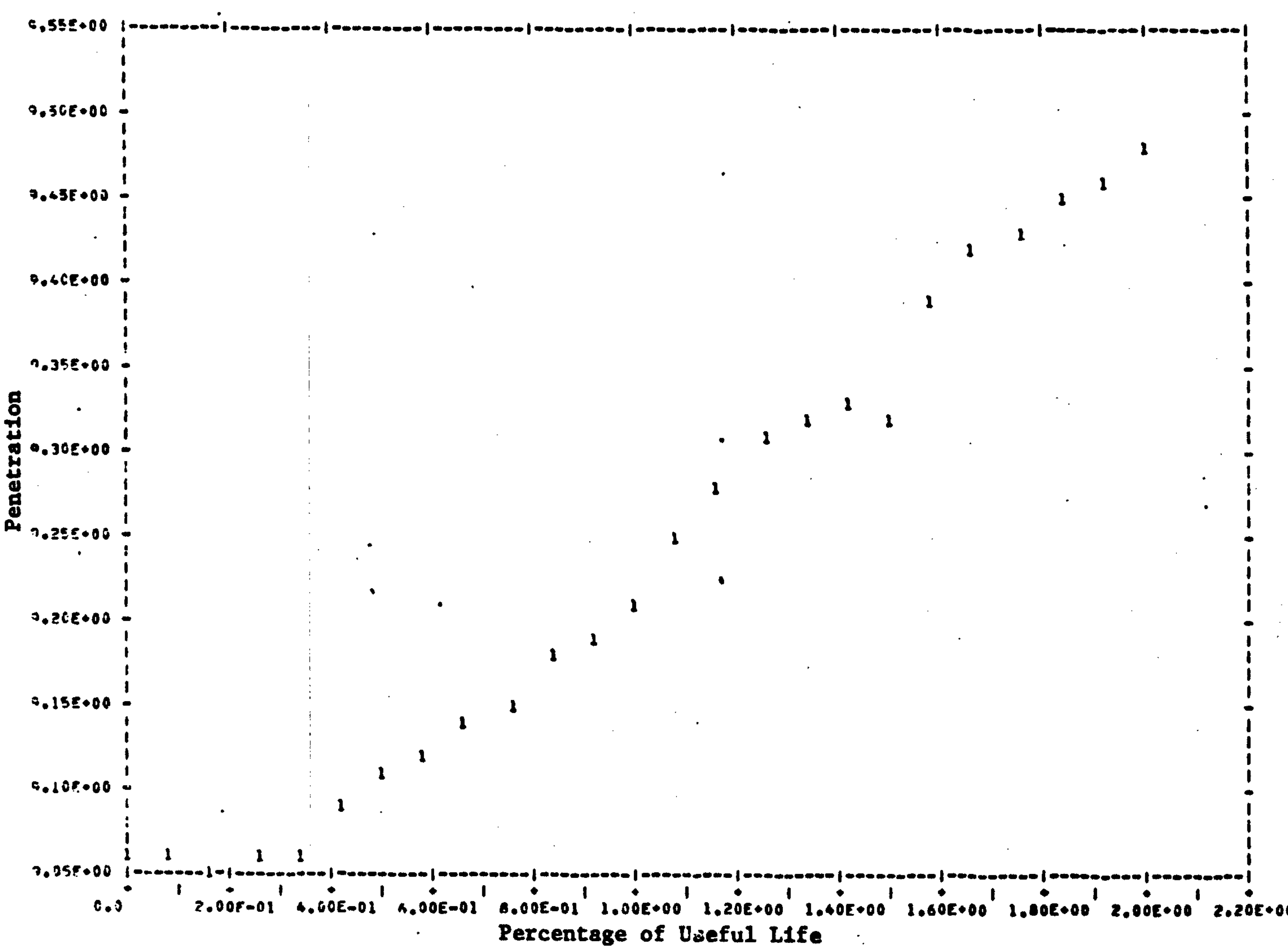


Figure 143 - Penetration of Gage 5 in M8

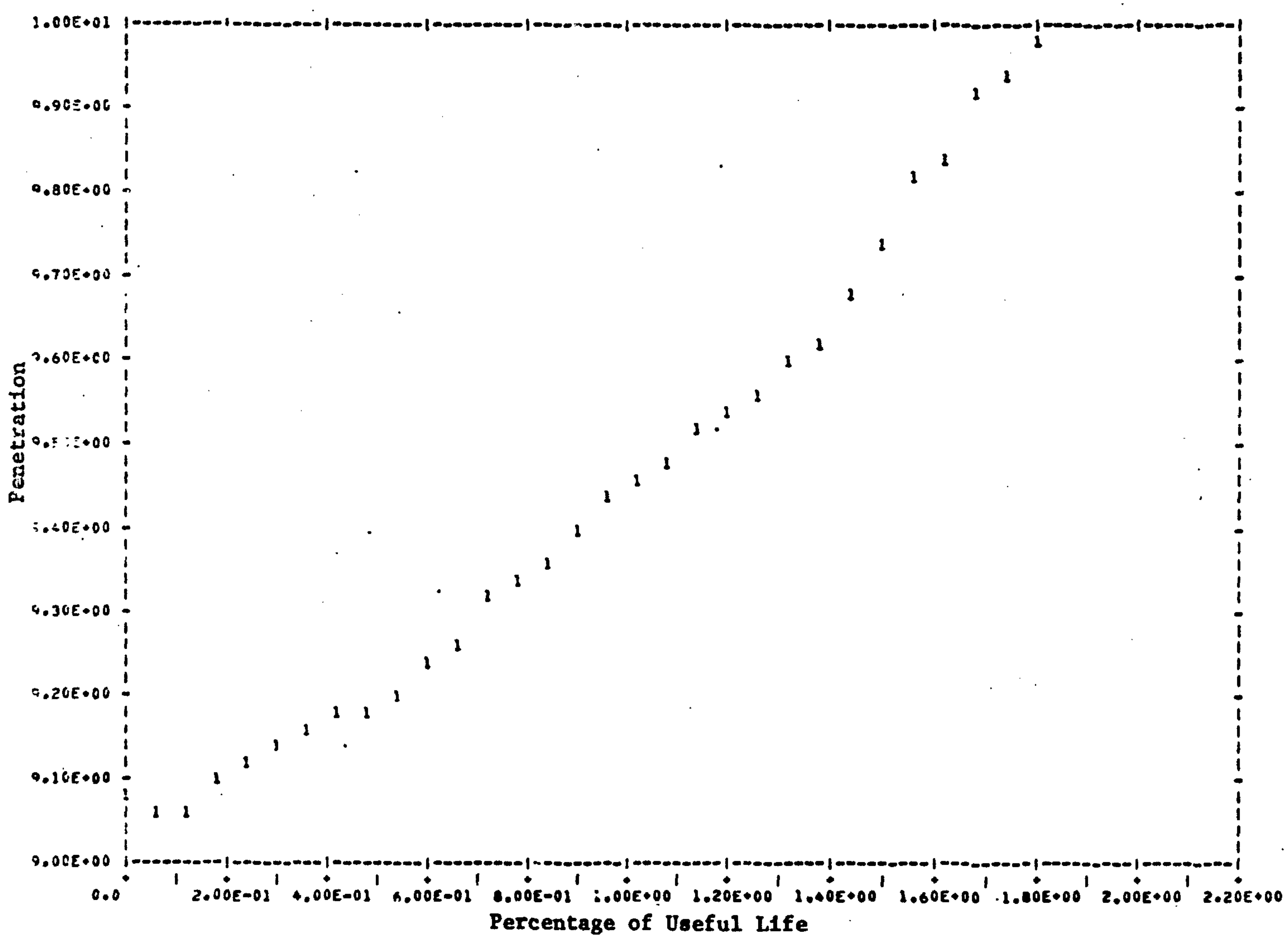


Figure 144 - Penetration of Gage 6 in C1

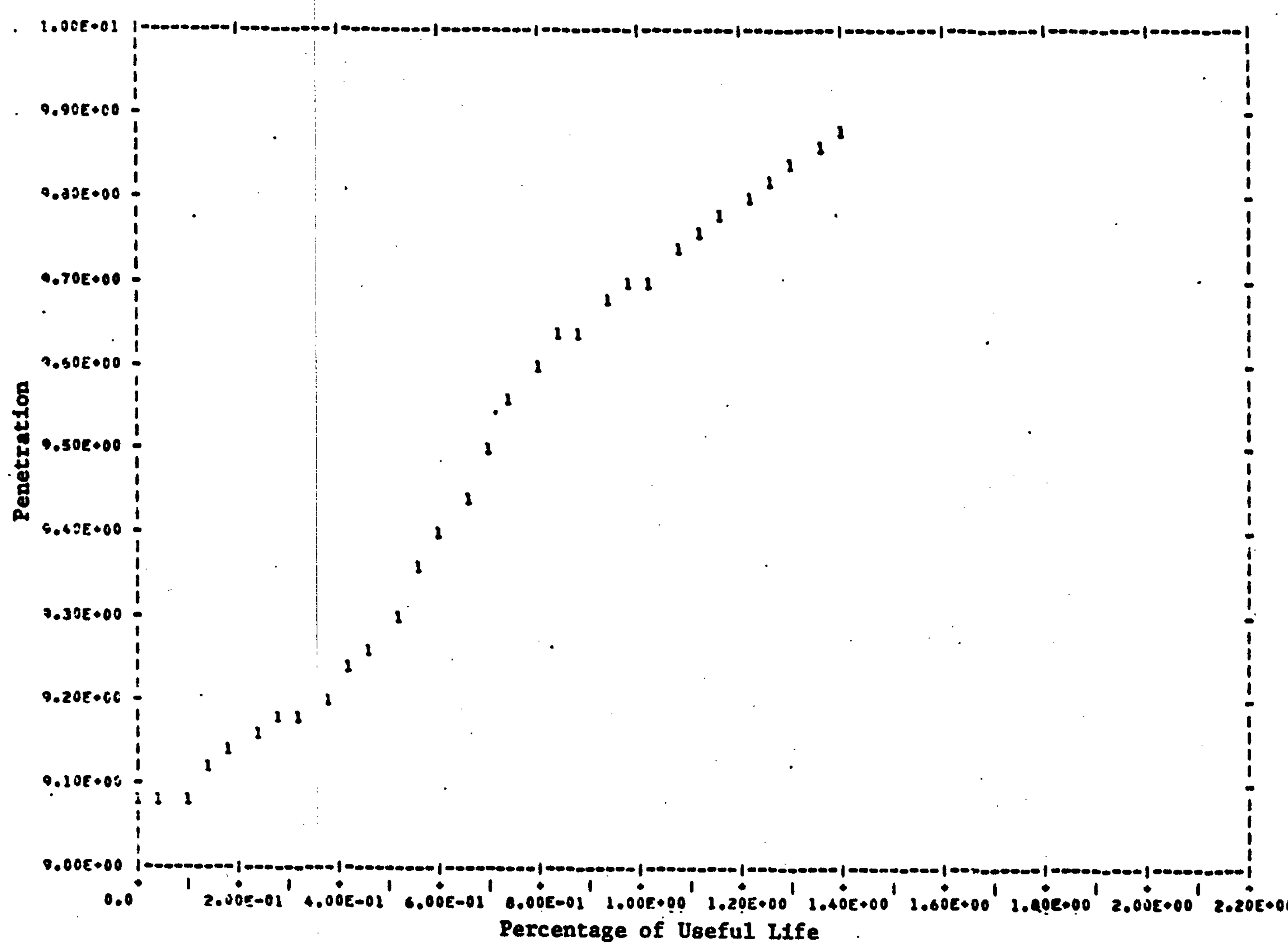


Figure 145 - Penetration of Gage 6 in C2

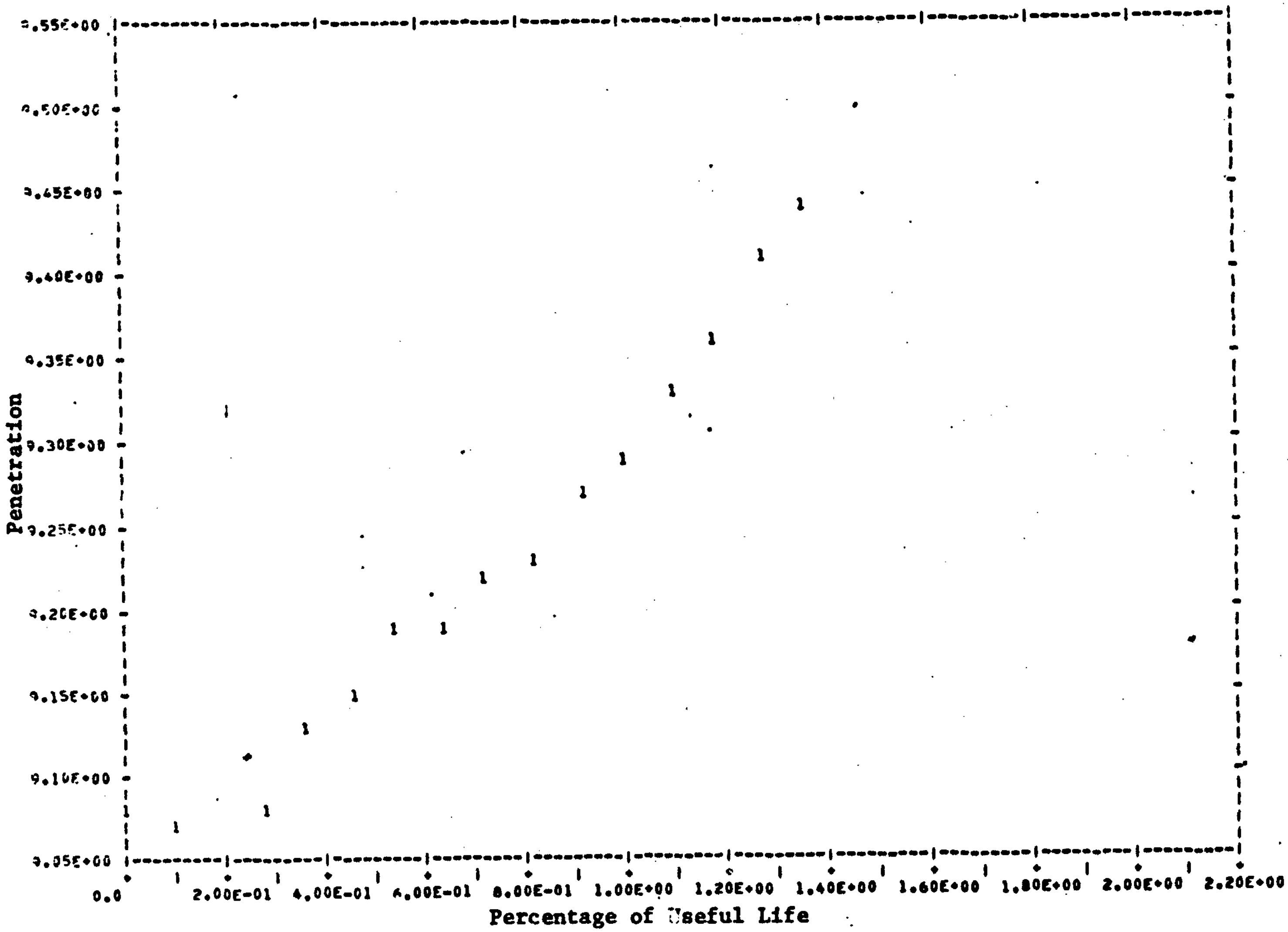


Figure 146 - Penetration of Gage 6 in C4

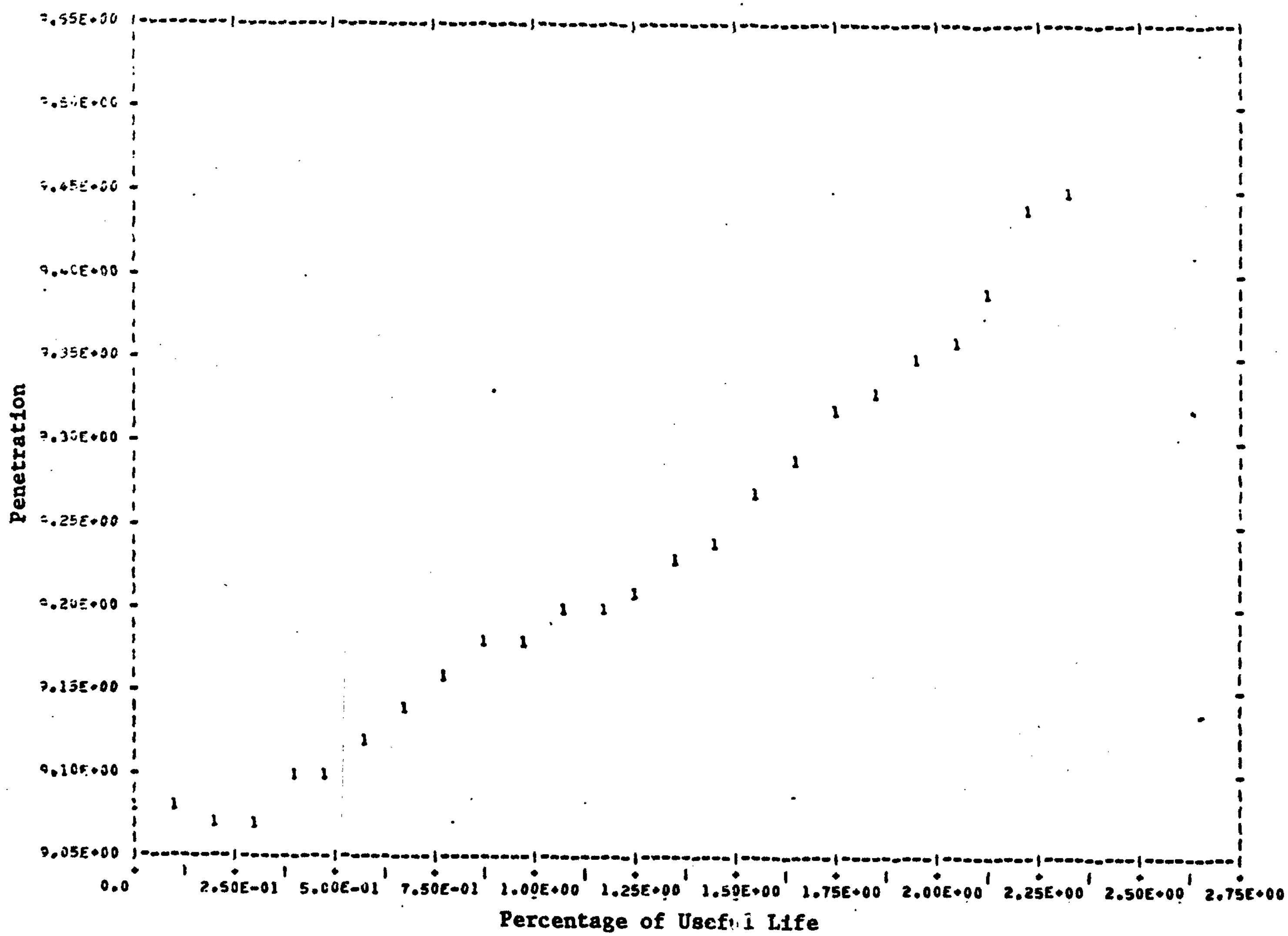


Figure 147 - Penetration of Gage 6 in C5

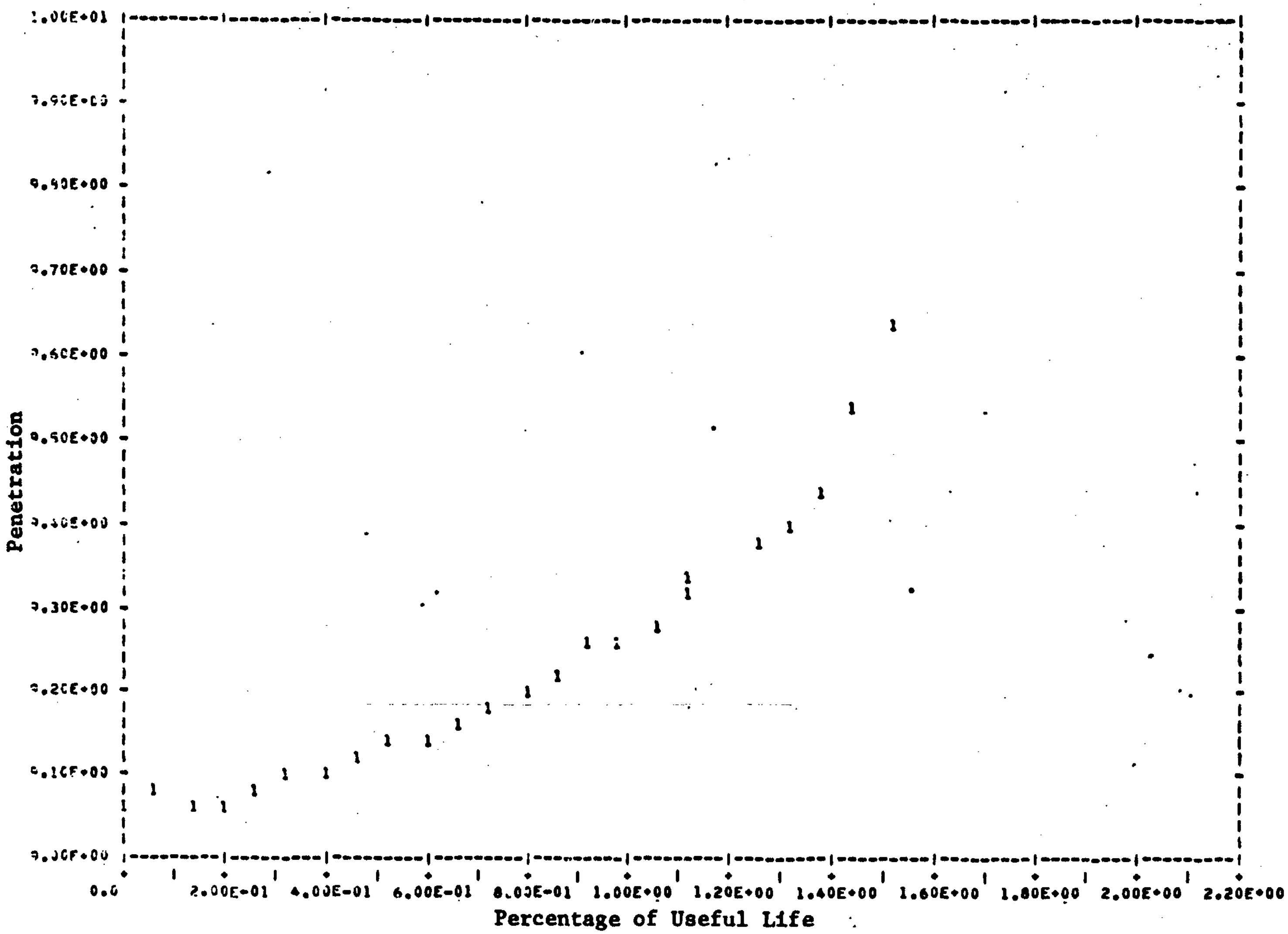


Figure 148 - Penetration of Gage 6 in C7

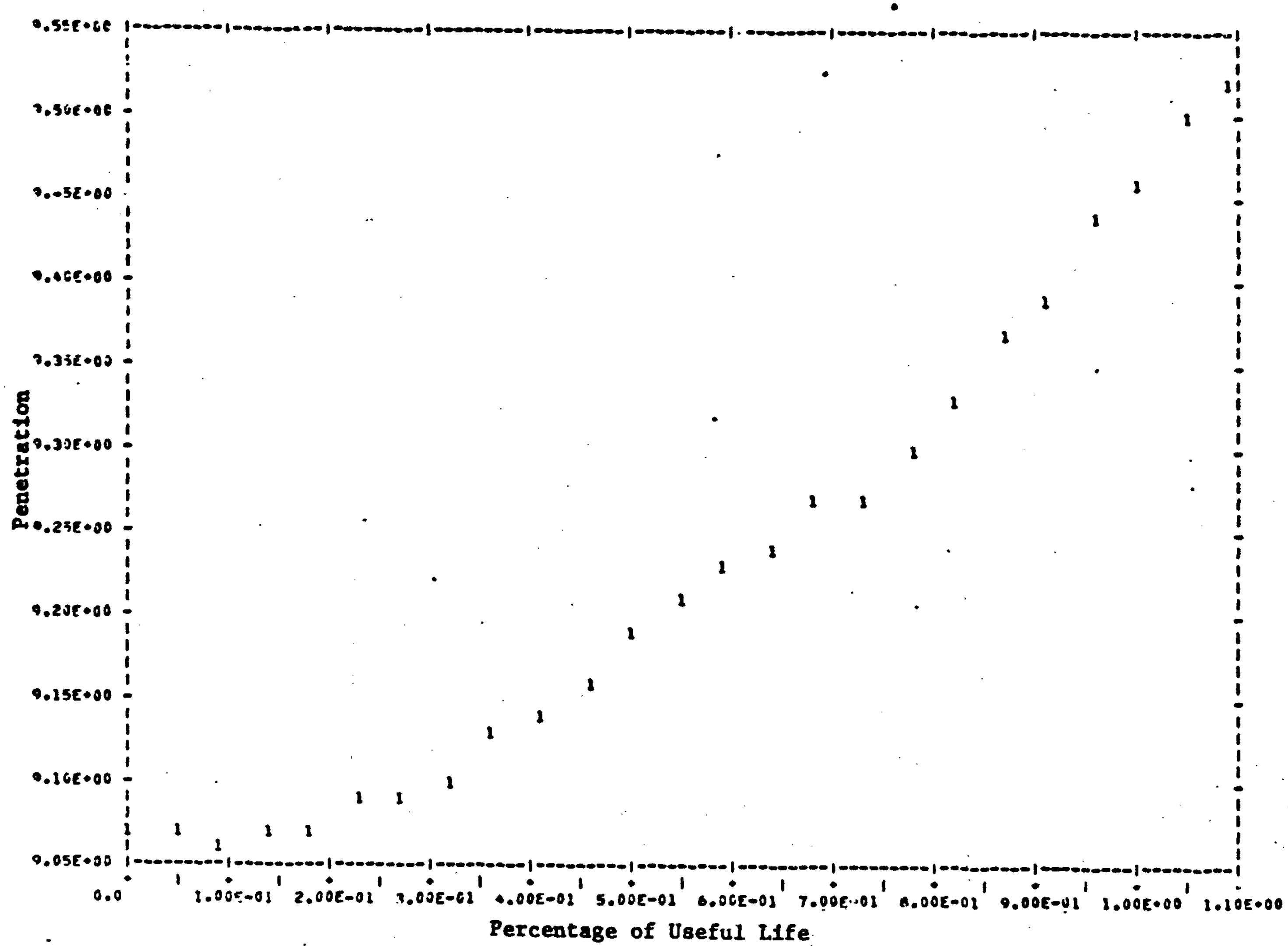


Figure 149 - Penetration of Gage 6 in C8

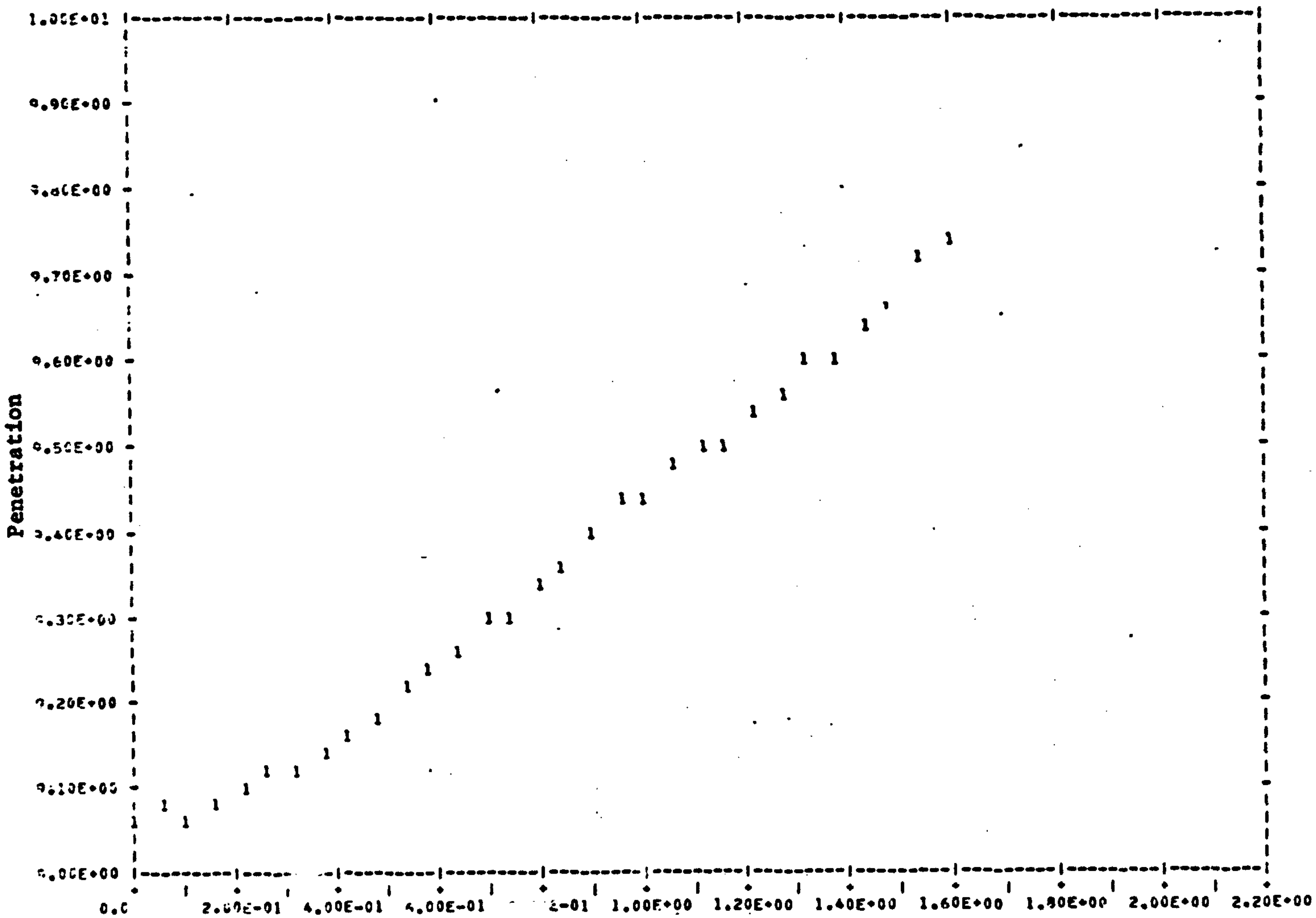


Figure 150 - Penetration of Gage 6 in GM1

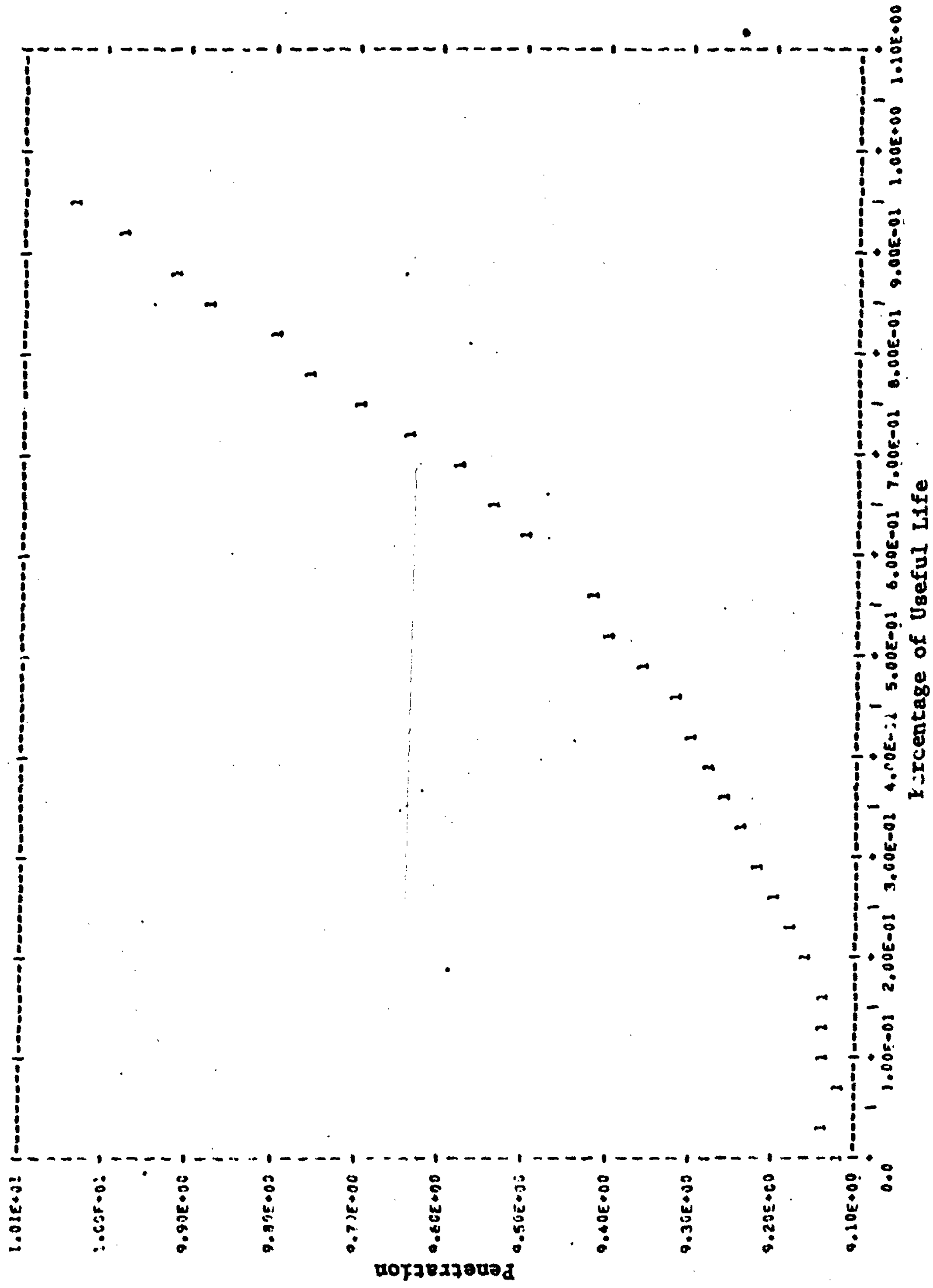


Figure 151 - Penetration of Gage 6 in GM2

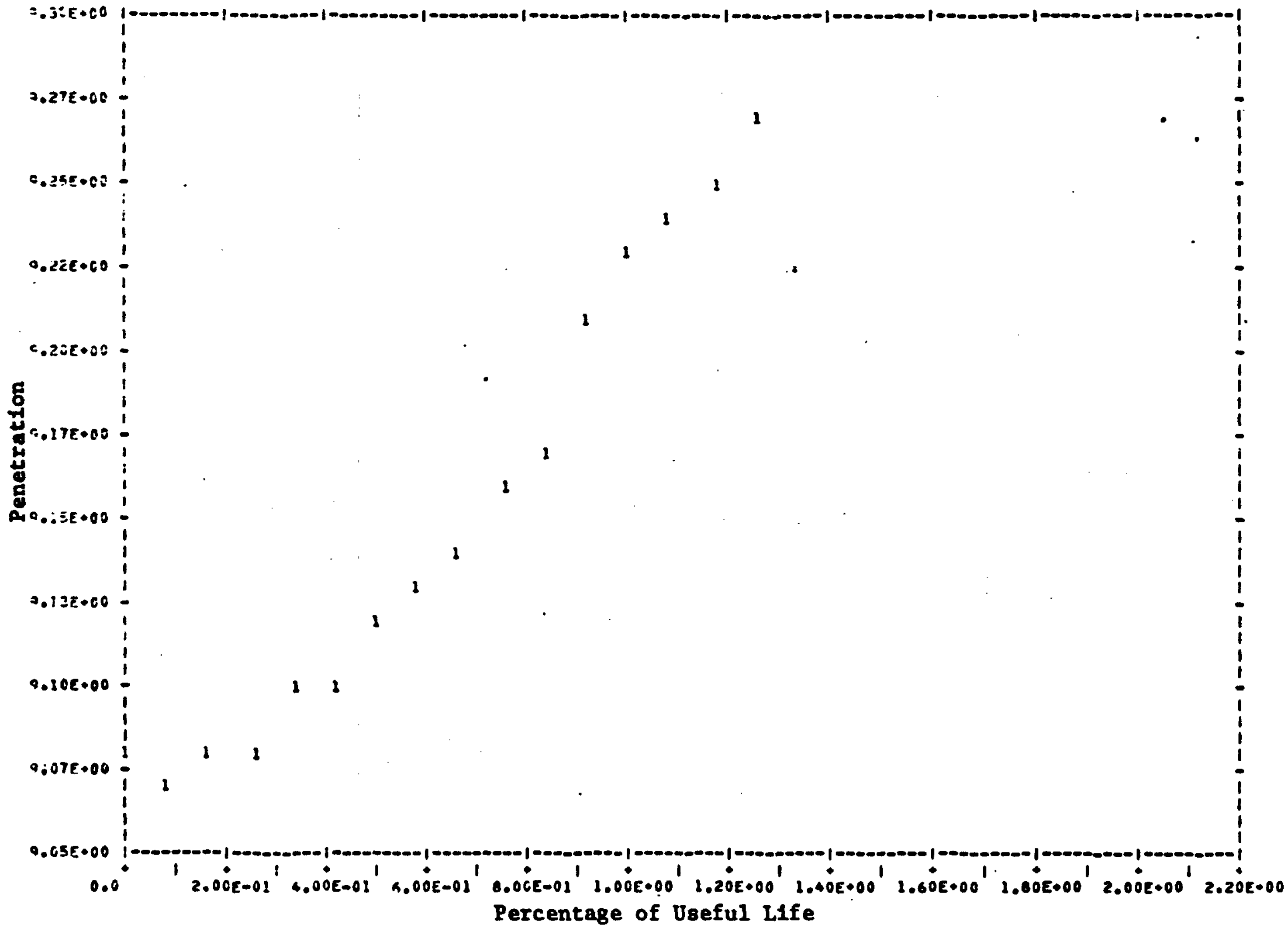


Figure 152 - Penetration of Gage 6 in GM4

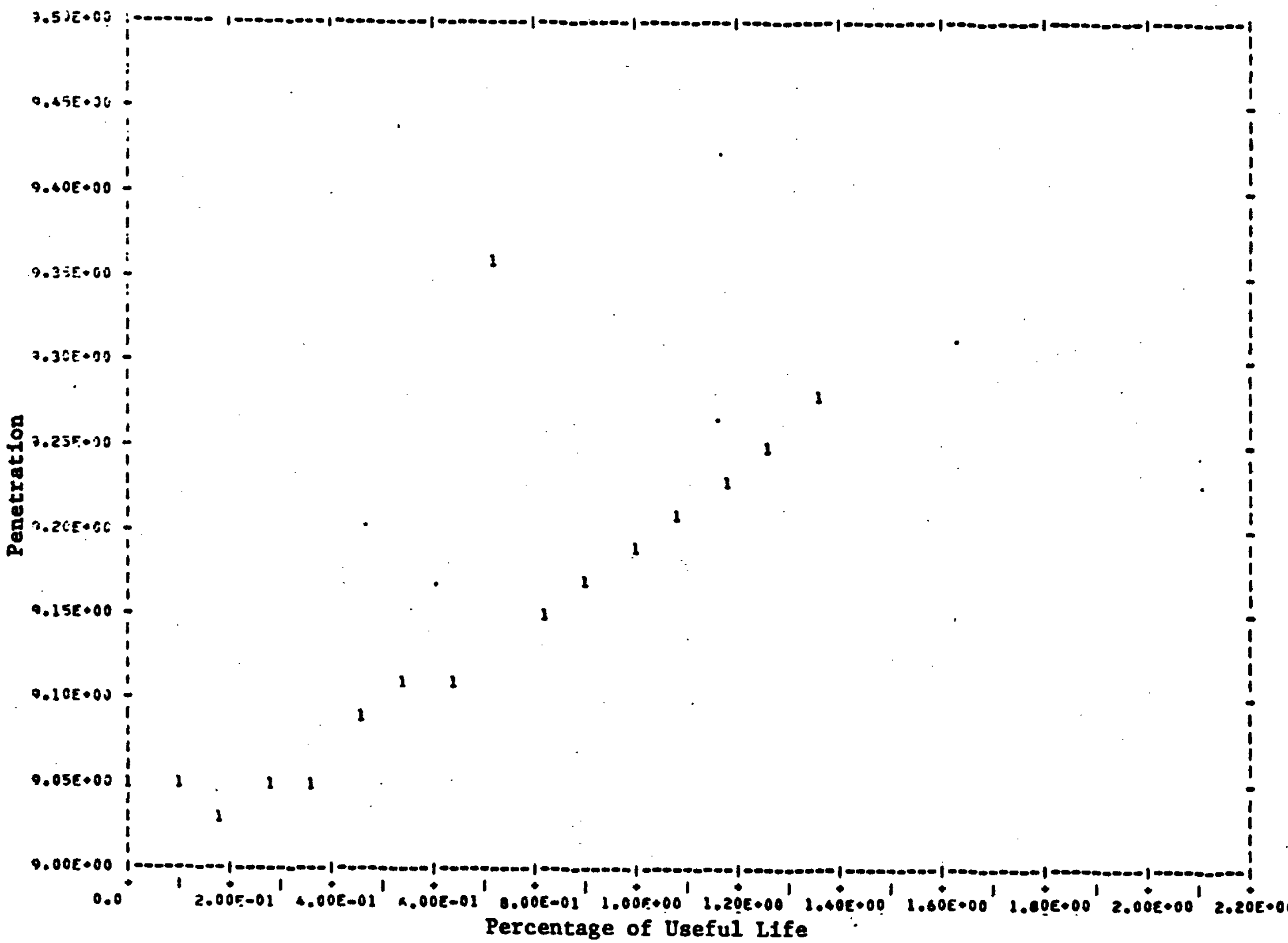


Figure 153 - Penetration of Gage 6 in GM5

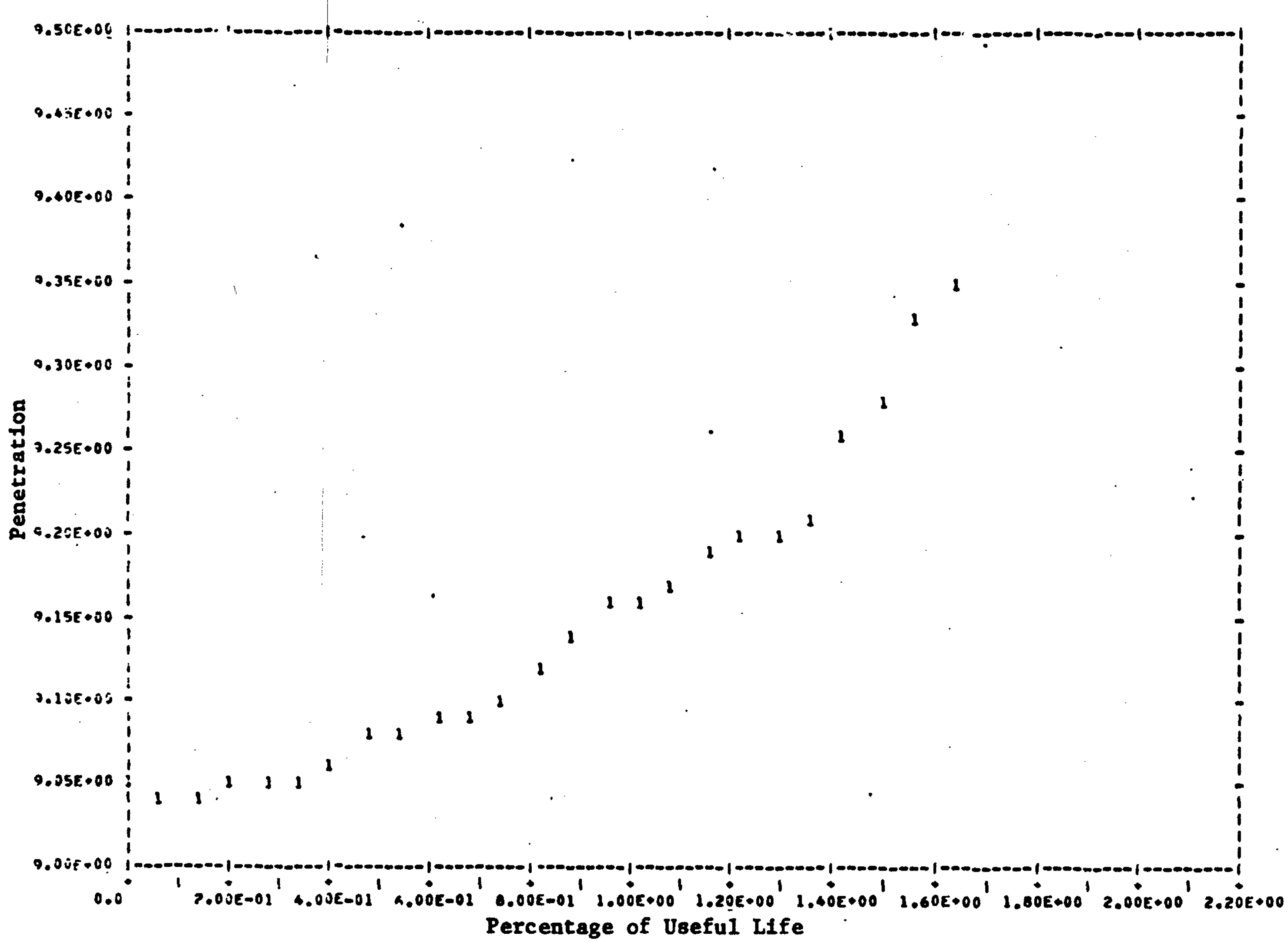


Figure 154 - Penetration of Gage 6 in GM7

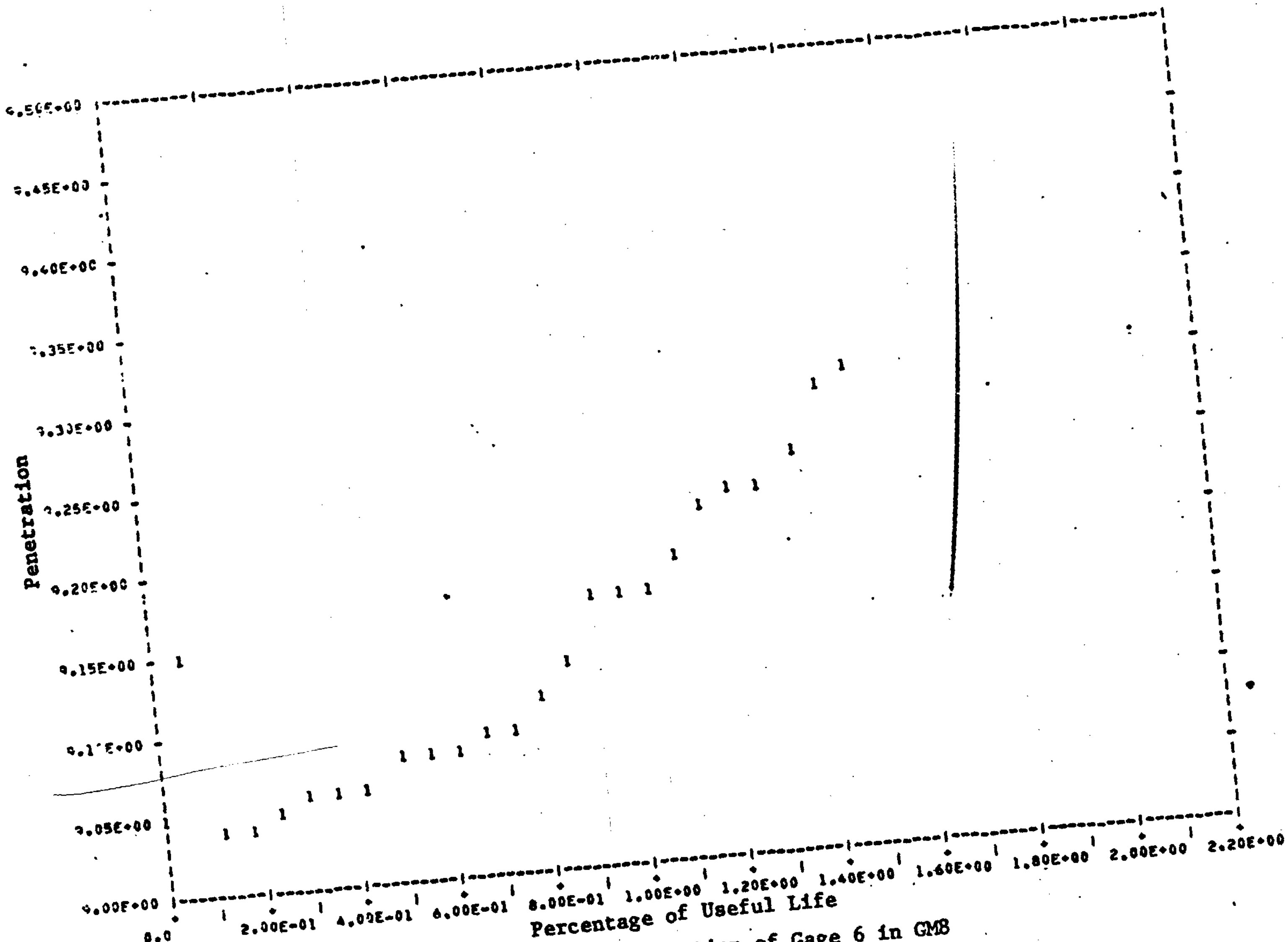


Figure 155 - Penetration of Gage 6 in GMB

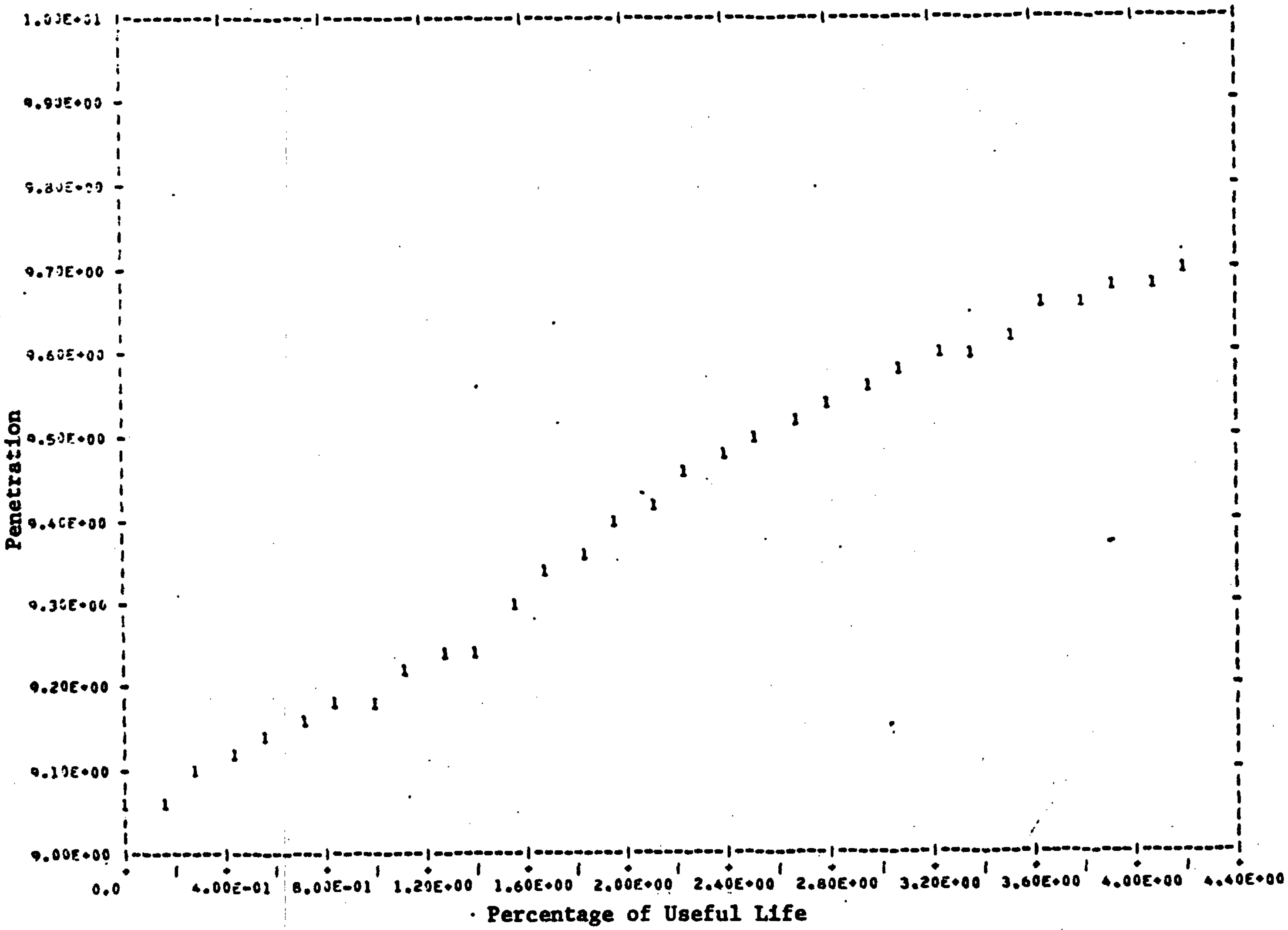


Figure 156 - Penetration of Gage 6 in M1

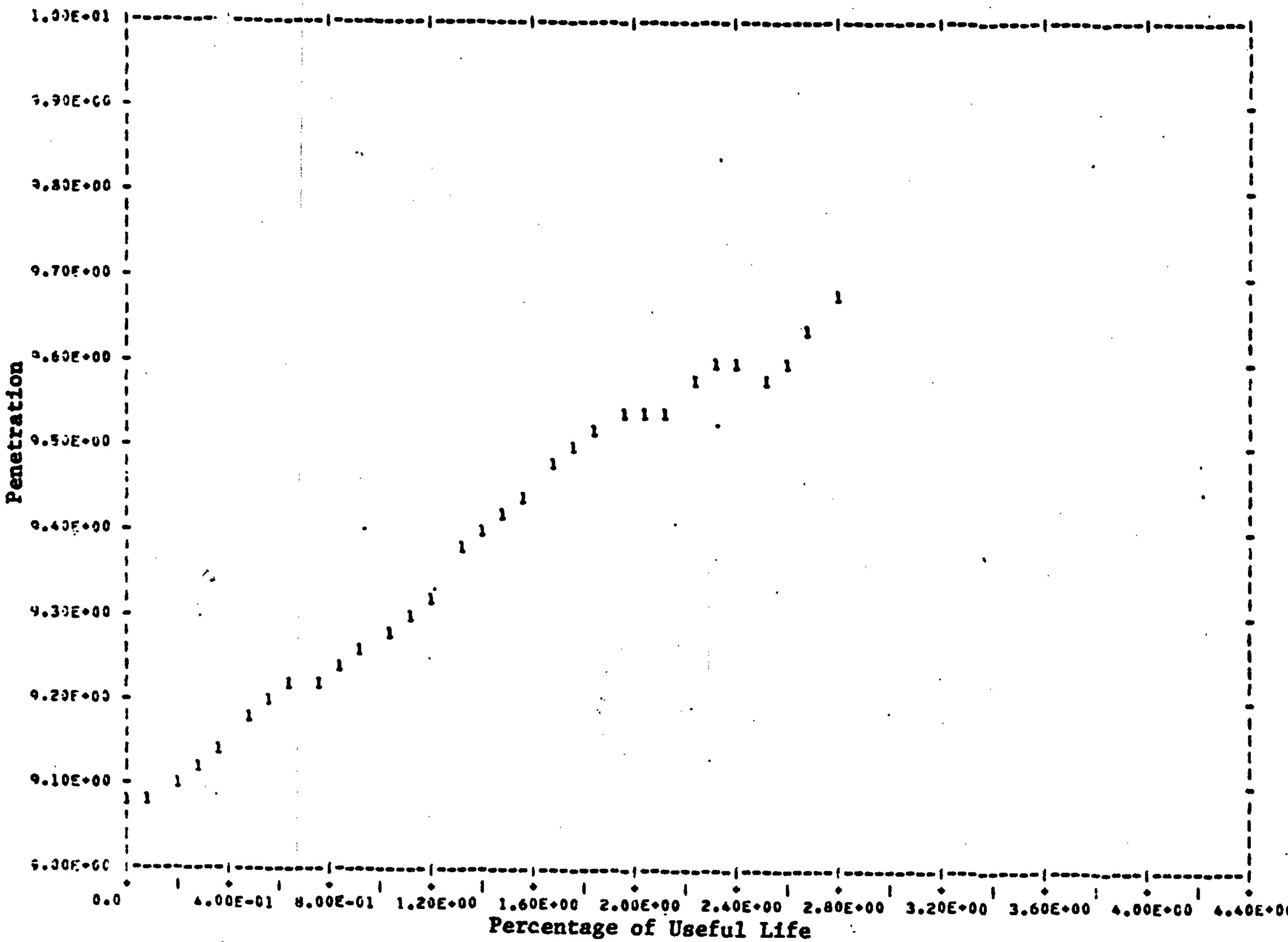


Figure 157 - Penetration of Gage 6 in M2

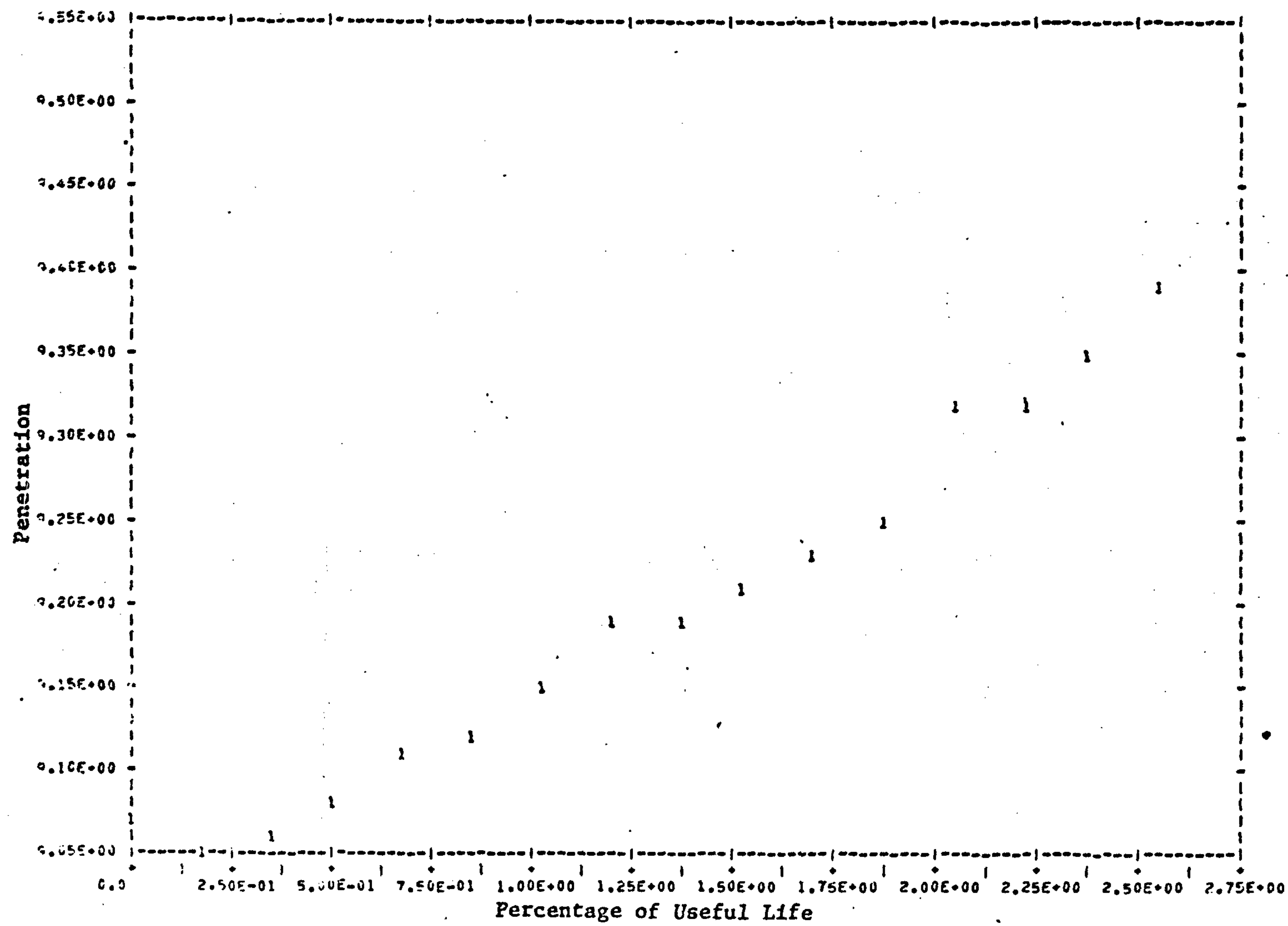


Figure 158 - Penetration of Gage 6 in M4

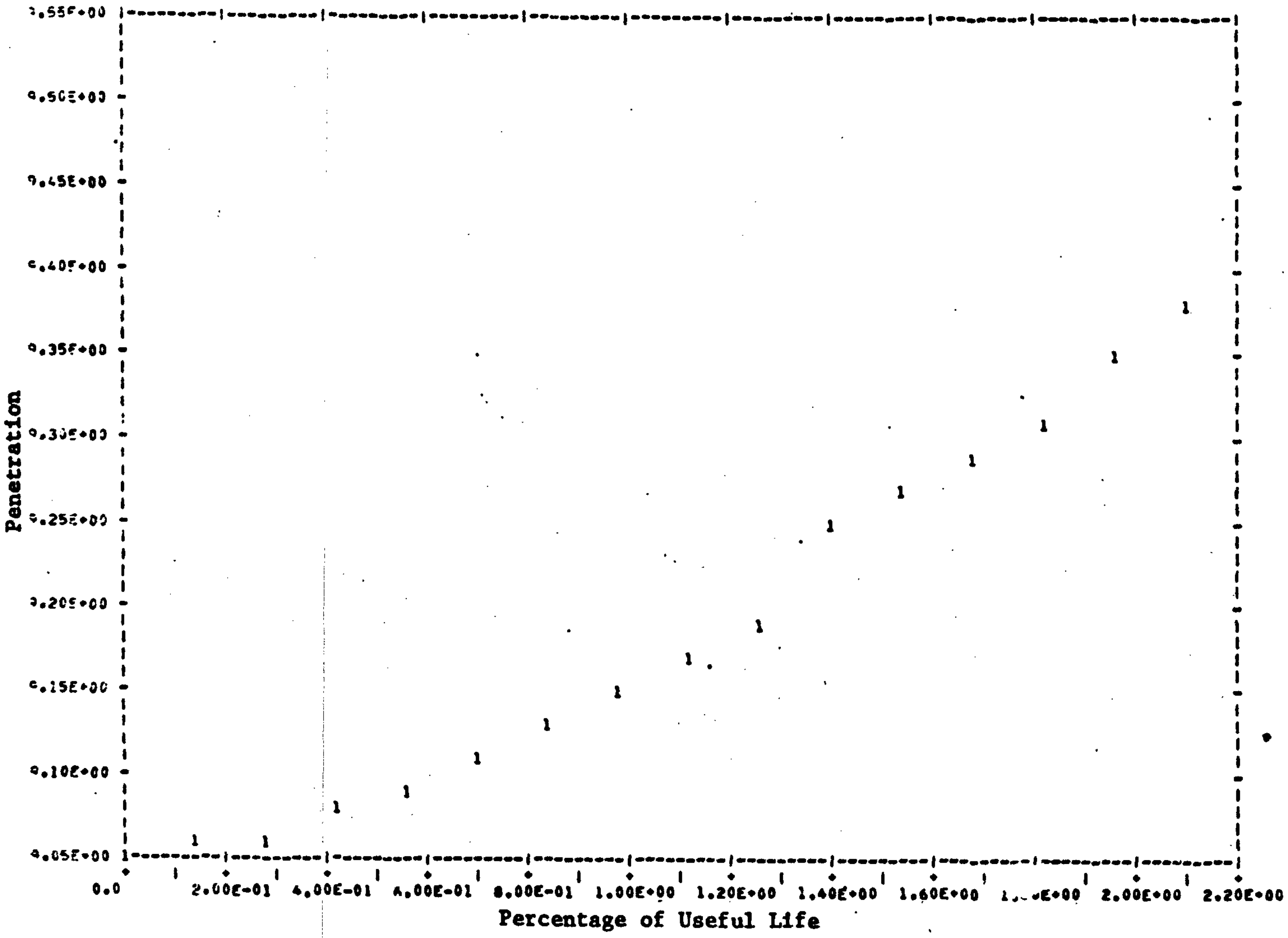


Figure 159 - Penetration of Gage 6 in M5

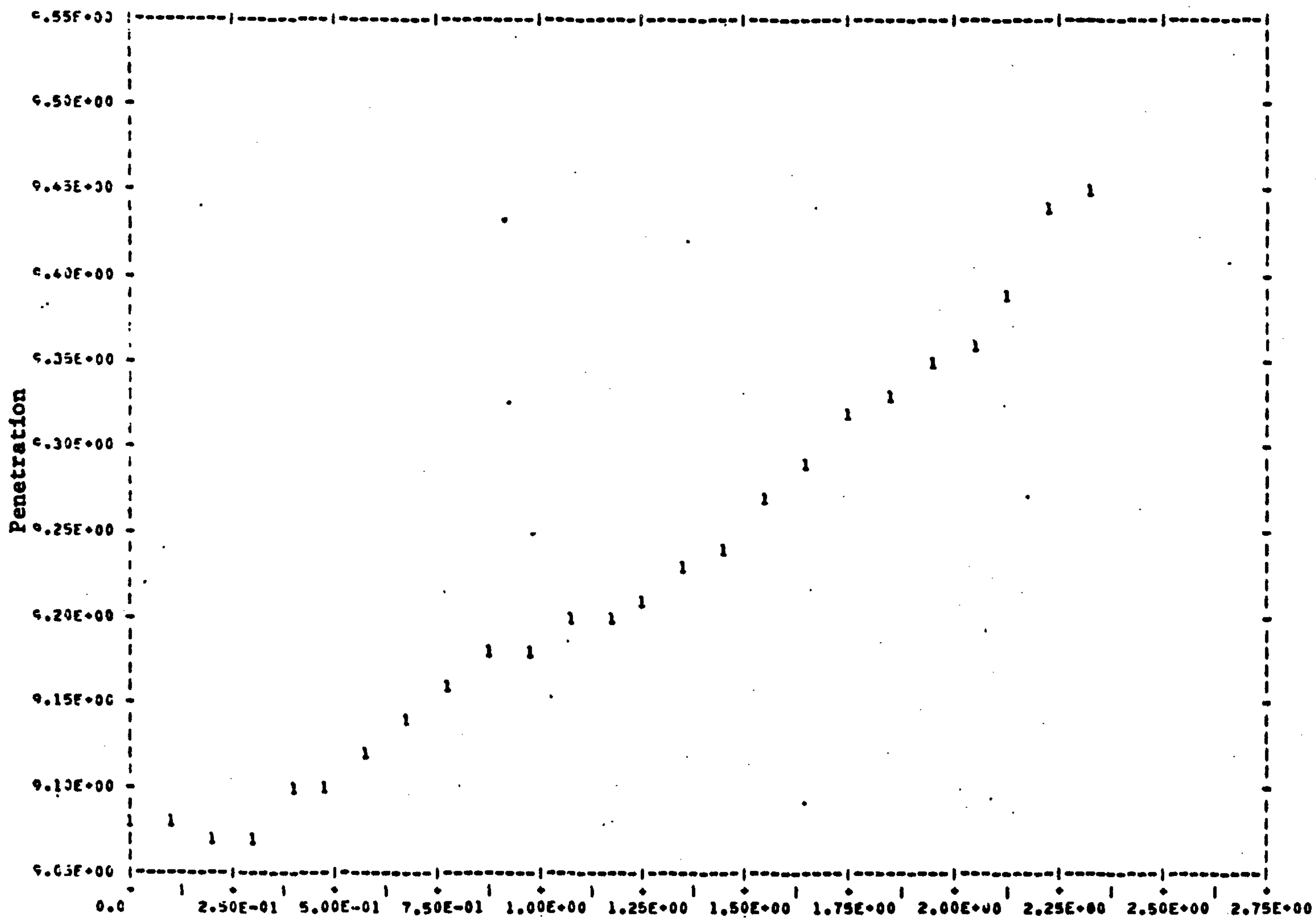


Figure 160 - Penetration of Gage 6 in M7

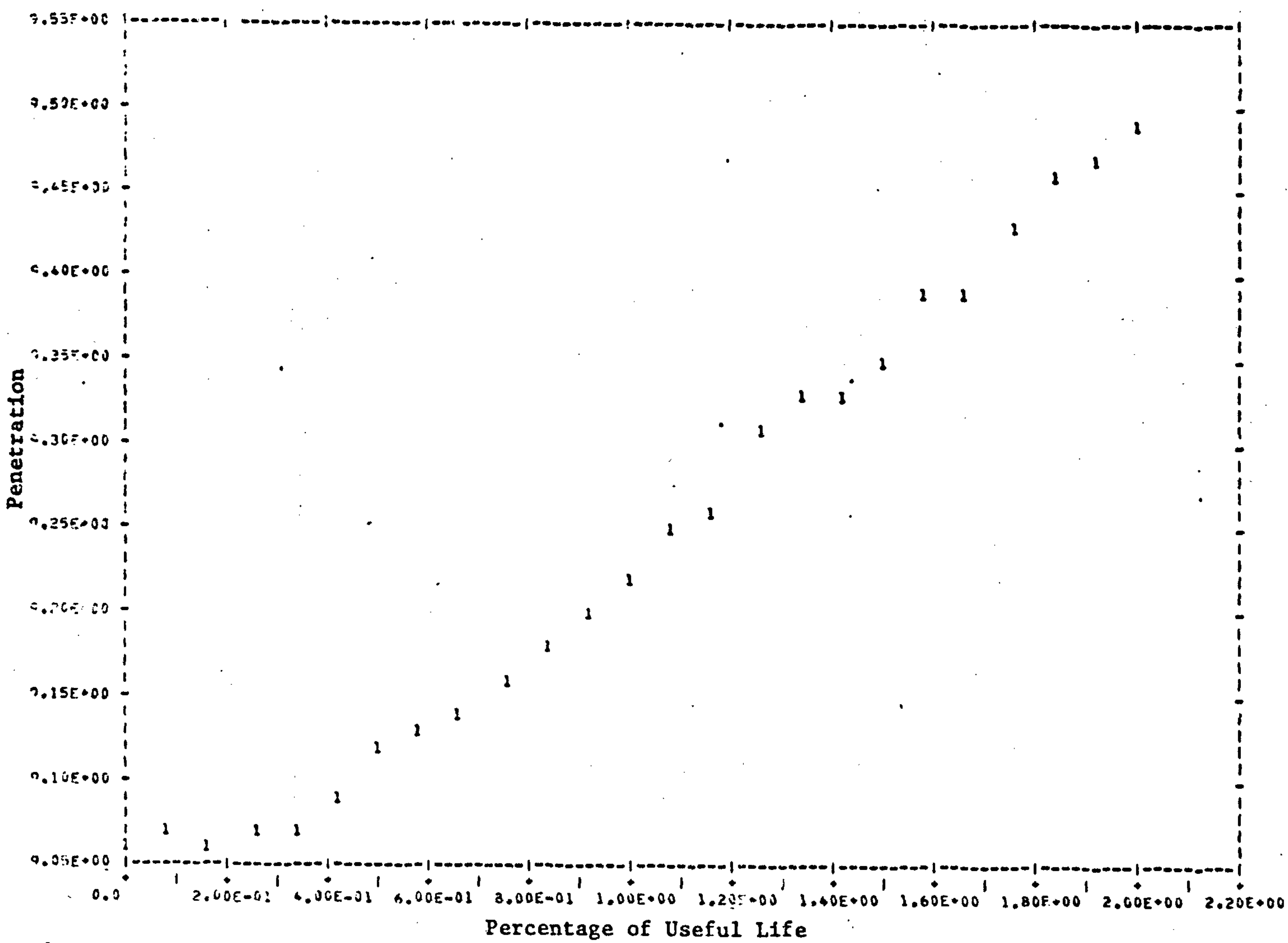


Figure 161 - Penetration of Gage 6 in M8

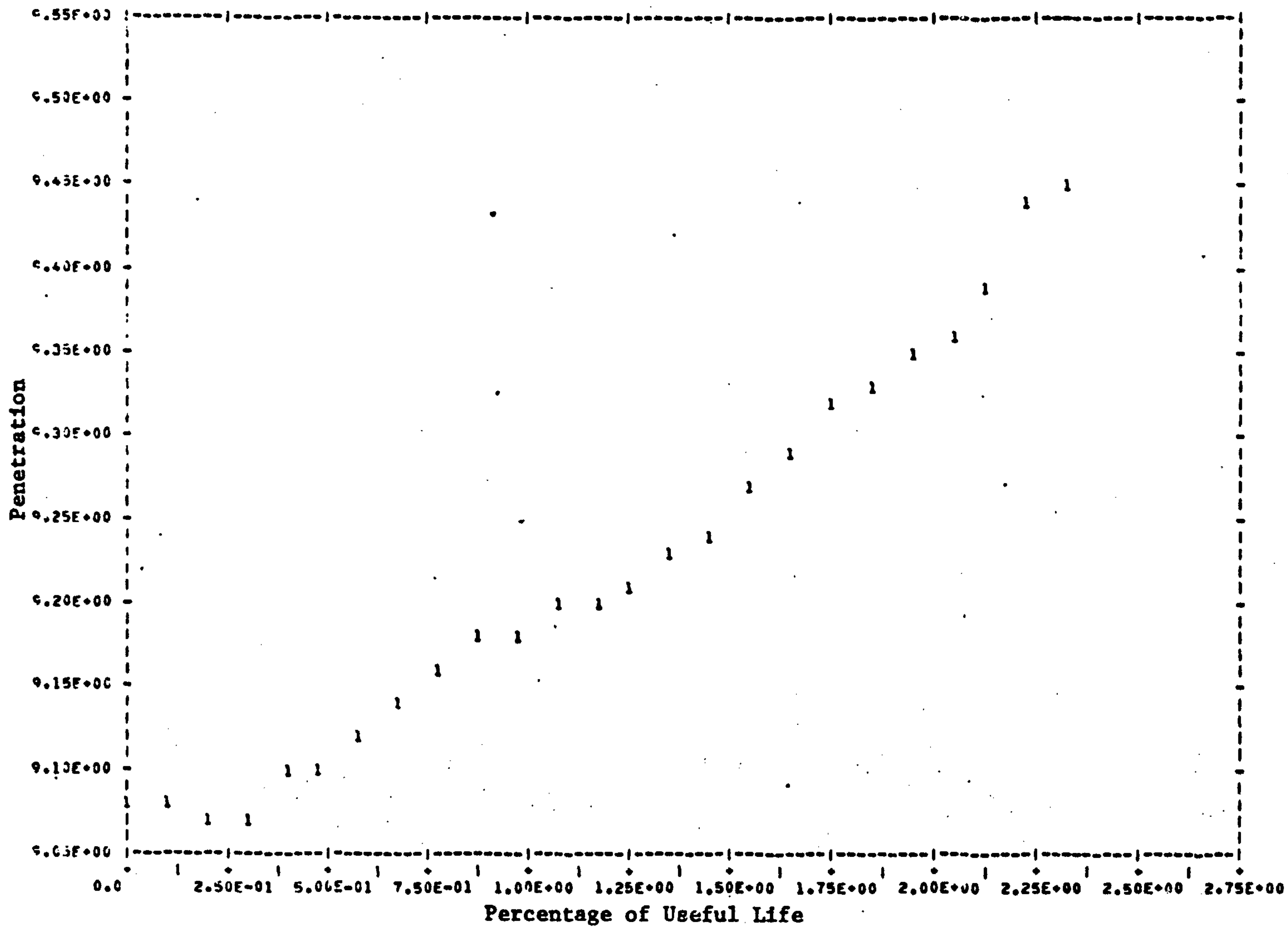


Figure 160 - Penetration of Gage 6 in M7

References

1. Pringle, Barry A., "Bore Erosion Gage Calibration Test for M16A1 5.56mm Rifle Barrels with Chrome Lined Bore," Weapons Test Division Job #74-35, Application Engineering Directorate, GEN Thomas J. Rodman Laboratory, December 1974.

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BORE EROSION AND ACCURACY OF M16A1 RIFLE

Prepared by: Dr. Rao Yalamanchili

Technical Report No. R-TR-77-055

173 pages, Incl Figures and Tables

An analysis was conducted on the performance of M16A1 rifles made by three manufacturers with the use of two kinds of ammunition and three rates of fire. The data include extreme spread and bore erosion gage measurements, each as a function of the number of rounds fired. Consistency is lacking in the experimental data, even though identical tests were performed. Probably, the random vibrations of the gun barrel or other unknown phenomena may be the reason for inconsistency of spread data. The inconsistency in the penetration of erosion gages may be due to fouling deposits on the bore surface and to lack of properly designed tools for unique

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